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Tech. Rep. 6
Part 1

List of Technical Reports, published under
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1 An Experimental System of Keys for the Interpretation of Vegetation on Aerial Photography.
December 1950 Restricted

2 The O'Neill-Nagel Table (A Multipurpose Light-Table) Its Uses in Photo-Interpretation of Color and Other Photography. September 1951 Confidential

3 Classification and Characteristics of Plant Communities in the Mountains of Norway. Summarized and translated from the Norwegian of Rolf Nordhagen.
May 1951 Restricted

4 Characteristics of Some Grassland, Marsh, and Other Plant Communities in Western Alaska.
December 1951 Not Restricted

5 Preliminary Keys for the Interpretation of Vegetation from Aerial Photography of the Arctic and Subarctic Regions March 1952.

6 Investigation of Methods of Determining Terrain Conditions by Interpretation of Vegetation from Aerial Photography.
January 31, 1952 Restricted

Part I
General Principles of Interpretation of Vegetation from Air Photographs and Their Incorporation into Keys.

Part II
Interpretation of Vegetation from Air Photographs of the Chesapeake Bay, a Type of Inland Shores. Supplementing and Summarizing Technical Report No 5.

Part III
Interpretation of Vegetation from Air Photographs of the Arctic and Subarctic Regions. Supplementing and Summarizing Technical Report No 5.

Part IV
Terrain Conditions Deducible from Air Photographs of the "Near Sub-arctic": Maine, Wisconsin, Colorado and Pennsylvania.

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INVESTIGATION OF METHODS OF DETERMINING TERRAIN CONDITIONS BY INTERPRETATION OF VEGETATION FROM AERIAL PHOTOGRAPHY

TECHNICAL REPORT No. 6

Part I. General Principles of Interpretation of Vegetation and Their Incorporation into Keys

Office of Naval Research
Project No. 257002
Contract N6-onr-25504

Arctic Institute
Catholic University of America

January 31, 1953

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R E S T R I C T E D
Security Information

INVESTIGATION OF METHODS FOR DETERMINING TERRAIN CONDITIONS BY INTERPRETATION OF VEGETATION FROM AERIAL PHOTOGRAPHY

TECHNICAL REPORT No. 6

Part. I. General Principles of Interpretation of Vegetation and Their Incorporation into Keys.

A contract between
the Amphibious Branch Office of Naval Research and the Arctic Institute Catholic University of America

Monitored by
Research and Analysis Division
Photographic Interpretation Center
Naval Receiving Station

Office of Naval Research
Project No. 257002
Contract N6-onr-25504

Hugh O'Neill, Chief Investigator

and

Arthur Barwick, Arthème Dutilly, Maximilian Duman, Herbert Hanson, Robert Heller, Ernest Lepage, William Nagel, R. J. O'Neill, Richard Shamp, Edward Steigerwaldt, Harold Young and Vincent Waldron.

ARCTIC INSTITUTE
Catholic University of America
January 31, 1953

R E S T R I C T E D
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SUMMARY

OF TECHNICAL REPORT NO. 6

Investigation of Methods of Determining Terrain Conditions by Interpretation of Vegetation from Aerial Photography

The Line of Thought Underlying This Research.

a) The Art of Fighting or TACTICS is the combined use of

PROTECTION

WEAPONS

MEANS OF MOVEMENT

b) VEGETATION MAY BE CONCERNED IN ALL THREE OF THESE

It may function as cover or concealment or even shelter to one or both opposing armies
It may function as cover or concealment or even shelter to their weapons
It may retard or accelerate movement of armies and
It may indicate roughly the extent to which the soil and/or subsoil underneath it, retard or accelerate movement.

c) This last point is the principal object of this research. However the other points mentioned may be properly included in "Terrain Conditions" in its widest sense and are considered here but as of secondary importance in this project.

d)Further, of the methods of interpreting vegetation from aerial photography, keys for this purpose were to be the principal object.

In Part I of this report, there is included:

1. An introduction attempting to show the place of photo-interpretation of vegetation in tactics and fundamental military theory.

2. A series of various types of keys to aid in the military photo-interpretation of vegetation.

3. A set of FUNDAMENTAL PRINCIPLES valid for deducing terrain conditions from vegetation in any part of the world.

4. A novel method of deducing terrain conditions from vegetation shown on color photography by the use of special filters and a special light-table.

5. Information additional to that detailed in Technical Report No 2 of this series, for the detection of camouflage.

6. Ways and means of improvising even on the battle-field special "rough-and-ready" filters, such as, a "fox-hole-detecting filter".

7. A set of seventeen differently colored sheets of paper to serve as

a) a means of improvising colored light

b) a short scale of color which have been designated by a standard system of names (Inter-Society Color Council and National Bureau of Standards Names) and a standard system of color notation (Munsell's).

c) as a means of training the photo-interpreter to think in terms of color photography and to be resourceful when working with it or any problems in photo-interpretation.

8. A set of eight plates (I to VIII) designed to train the photo-interpreter in deducing from vegetation on photographs such military information as: the location of road-building materials; the recognizing of some factors of the local climate; the height of the water-table; the implications of seasonal changes in camouflage, etc.; the sensitivity of marshes as recorders of military operations.

9. A set of six plates of air photographs (two from New York; four from Texan forests) illustrating the best and the poorest means of detecting browning of vegetation. When properly studied, browning of vegetation can sometimes reveal enemy operations.

10. A set of five plates demonstrating that a snow-fall does not always veil terrain conditions from the sight of the interpreter but often reveals them even more clearly than ever.

11. A set of five plates showing stereo air photographs interpreted for travel and other terrain conditions in the fir-pine forests of a southern extension of the subarctic coniferous forest in Orégon and Colorado.

12. A nine-page glossary of definitions or terms used in this report and in more or less general use in the photo-interpretation of vegetation, elsewhere.

13. A chart showing the transliteration from the Russian or Cyrillic alphabet into the Roman alphabet for use in dealing with Russian titles of maps, books, etc.

14. Two practice sheets by which the interpreter can learn transliteration without a teacher, and can realize that occasionally transliterating is tantamount to translating in the case of Russian foreign words and scientific terms.

15. A set of 66 practice-questions and answers in photo-interpretation based on thirty plates of photographs of vegetation on subarctic mountains.

16. A similar set of 24 practice-questions and answers based on 26 plates of the subarctic lowlands.

17. A detailed fifteen-page index for all four parts of this report.

In Part II of this report, there is included:

1. A rapid, original "scanning" method of deducing terrain conditions from even small-scale air and/or ground photographs, using both landforms and associated patterns of vegetation, whereby the landforms indicate the general conditions; and the vegetative patterns, the details of the terrain conditions within each type of landform.

2. "Air photographs taken when there is snowfall on the shores of the Bay do not, as is commonly thought, blot out all possibility of interpreting terrain conditions but on the contrary, increase the information the interpreter can deduce especially as regards marshes. Observations made in the Bay area were extended to Canada and are treated as generalization in Part I under Snowfall Series illustrated by 5 plates."

3. "Observations on the marshes in the "Bay" and on snow-covered terrain led the Project Director to consider both of these as a very sensitive medium on which military movement cannot be made without leaving traces which are readily recorded and even more readily interpreted on air photographs. Because these observations were expanded into generalizations probably valid the world-over, they are described in detail in Part I. It should be stated here that mine-laying, setting barbed-wire, or any military movement in a cat-tail marsh is indelibly betrayed on a vertical photograph."

Part III of Technical Report No 6 presents a photo-interpretive study of a comprehensive variety of sample areas of the three main divisions of Arctic and Subarctic regions:mountains, lowlands, and shield areas. The following first three "test locations" were judged to be representative of these main classifications, with the remaining studies regarded as "test locations" for conditions intermediate between these three great classes:

Lowlands - test location: James Bay

Mountains - test location: Nahanni Valley

Shield Areas - Kaniapiskau, and Val David in the Canadian Shield,in Technical Report No 5.

The lowland "test location" represents fairly well much of the subarctic lowlands elsewhere, as the lowlands of Poland, the Pripet Marshes, the Mazurian lakes, as well as vast areas in the central Siberian Plain, the largest plain in the world.

The mountain "test location", used to study terrain conditions deducible from vegetation seen on air photographs, was made in one of the wildest, most inaccessible and rugged mountain areas of North America, and was considered comparable to mountainous regions elsewhere in the Arctic and Subarctic, e.g. in northeastern Siberia, Kamchatka, etc. In such areas, game trails were discovered by Shamp's party to be often the best and only routes of travel for small parties, such as, those engaged in reconnaissance or intelligence.

In the Arctic a large portion of the earth's surface is covered with ice and snow from six to twelve months of the year. Snow therefore forms the commonest background in very much of the photography of the Arctic. Hence the necessity for the photo-interpreter to recognize a considerable number of objects other than ice and snow which appear white on Arctic photography.

Noteworthy innovations in Part III include:

1. A new means of deducing landing conditions on Arctic beaches from patterns of living and dead seaweeds at various tidal levels, and the dead seaweed, driftwood and flotsam and jetsam on the strand of the beaches.

2. The use of air photographs taken by a small hand camera in correlation with smaller-scale photographs taken by an aerial camera (a 9-lens camera of the Coast and Geodetic Survey) in the Matanuska Valley, Alaska. Ground photographs and field studies of the vegetation were correlated in turn with this double set of air photographs to provide the photo-interpreter with an example of correlating small-scale vertical photographs with moderate scale oblique air photographs, and with field

studies of the vegetation on the ground.

3. A study of terrain conditions deducible from air photographs in a peat-cutting area in the subarctic spruce-fir forest, using as a "test location" Pointe-au-Père, Rimouski, Québec, somewhat similar to the Irish, Russian and Baltic peat-districts.

4. A means of training photo-interpreters in the use of information not on the photographs themselves. For this purpose the expedient of using maps. all on the same scale and same style of projection, and therefore superposable, enables the photo-interpreter almost at a glance to ascertain the correlation or non-correlation of different factors affecting terrain conditions and vegetation, and thus assisting him in interpreting photographs of the region represented by the maps.

5. A Botanical-Climatic map of the Arctic regions giving the approximate boundaries for the Arctic and subarctic regions of vegetation as understood in this Report.

In Part IV there is included:

1. A stand of terrain conditions in northern half of Maine and the recognition of roadbuilding material from landforms and vegetation seen on air photographs.

2. A set of four plates illustrating terrain conditions in a mixed pine forest and grassland in Colorado. (C 1-C 4)

3. A set of eight plates (D-1 to D-8) illustrating the use in photo-interpretation of a series of air pictures and ground pictures, all taken by a small hand camera, by the same interpreter within the space of two hours in what may be considered as practically a southernmost extension of the subarctic in attenuated form, nearly obliterated by the advancing temperate oak forest.

4. A series of ten plates (P-1 to 10) illustrating the subarctic forest at what is practically its southern boundary, as well as the effects of open-pit mining on vegetation as seen on air photographs.

5. A set of twenty-six plates showing matched stereo-air and ground photographs of the twenty-six principal types of vegetation in the sub-arctic region of northern Wisconsin.

ACKNOWLEDGMENTS

It is a pleasant duty of the Project Director to extend grateful acknowledgment to those who have helped in the making of this Report. The generous permission of the Royal Canadian Air Force to reproduce in this Technical Report fourty-nine air photographs is deeply appreciated.

Lt. Col. C.R. Schwenke, USMC, and Lt. J.W. Hallstead, USN, and their successors, Col. J.P. Stafford, USMC and Lt. W. B. Murray, USNR, in the Office of Naval Research, the Amphibious Branch, have been unfailing in their cooperation always cheerfully given.

From the Photographic Interpretation Center of the Naval Receiving Station, the utmost assistance has been extended to us at all times in regards to making aerial photographs, consultations, and in trying our identification keys in the classes at PIC. Mr. Page Truesdell and Dr. (formerly LCDR.) Robert Colwell have been most helpful monitors.

For very much original and unpublished information and photography of Arctic and Subarctic Canada, made during the twenty year period of 1933-1952 on seventeen Arctic expeditions, I am most heavily indebted to Rev. Arthème Dutilly, O.M.I., Director of our Arctic Institute, and to his associates, Dr. Maximilian Duman and Ernest Lepage. Dr. G. Gardner, Curateur du Musée de l'Ecole des Hautes Etudes Commerciales, Université de Montréal, has generously supplied information and photography of Labrador and the Laurentides.

To Dr. Herbert Hanson, I am indebted for a fine set of air photographs taken by himself with a hand camera while making additional studies of the vegetation of Alaska, - studies made during the periods of 1940-45 and 1948-52. In addition, Dr. Hanson also made, especially for this report, a series of field studies in Colorado which he connected with the series of air photographs.

Mr. (formerly Sergeant) Vincent G. Waldron has given most valuable suggestions based on his field and battle experience in the campaign from Normandy to Berlin, and has been of constant assistance in the many phases of the preparation of this report.

Dr. William Donahue of St. Thomas College, Scranton, has kindly supplied gratis, ground studies and photography of the cold temperate forest of Pennsylvania. His work was incidental to his doctoral dissertation.

Dr. Harold E. Young, Department of Forestry, University of Maine, under a subcontract has supplied a very large amount of first-hand, technical information, ground color photography and field studies, corresponding to air photographs of the northern half of the State of Maine. In Wisconsin, Edward Steigerwaldt has carried on similar studies and has supplied excellent matched air and ground photography in stereo-pairs, forming the W 1-26 series of plates in Part IV. Most regrettably, limitations of time and space made it impossible to use much of the results and photographs of the excellent field studies made by Dr. Hanson, Dr. Young and Mr. Steigerwaldt.

Mr. Richard Shamp and his associates, Mr. Norman Thomas and Mr. Howell Martyn, under another subcontract, made a series of interesting ground photographs and information which they have ingeniously correlated with air photographs of perhaps one of the most inaccessible and wildest regions of interior North America.

Mr. Robert Heller of the Forest Insect Laboratory of the U.S. Department of Agriculture, Beltsville, Md. has supplied a series of air photographs of unusual interest in research in air photography.

Dr. Arthur B. Barwick, Head of the Department of Geology of Howard University, has painstakingly redrafted a set of twenty superposable maps of the USSR, and has contributed considerable geological advice during the course of this project on which he has worked tirelessly.

The Project Director wishes to acknowledge the benefit he has derived from exchanging views, and discussions while making studies in the field in the Chesapeake Bay area with

Dr. George Carter, Head of the Bowman School of Geography of Johns Hopkins University. The Chesapeake Bay Institute has kindly assisted with their published studies, as well as with the facilities of their ship last summer. Dr. Kenneth Bertrand, Head of the Department of Geography of Catholic University has given advice on interpretation of glacial features on some of the air photography studied.

Mr. William Nagel has been most cooperative and most painstaking in processing nearly all of the ground photography made in connection with this entire project.

Hugh T. O'Neill

Project Director.

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Landforms and Vegetation as Indicators of Road Building Material

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(continued)

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APPENDIX I: Snowfall Series

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(continued)

APPENDIX II: Travel Conditions in Fir-Pine Forests

OC-Series, Oregon and Colorado

INTRODUCTION

This is the FINAL REPORT of Project No. 257002, Office of Naval Research, entitled "Investigation of Methods of Determining Terrain Condition by Interpretation of Vegetation from Aerial Photography."

Since the central idea of this title and project is TERRAIN CONDITIONS, it seems appropriate to state here what Terrain Conditions signify in National Defense as understood here. To put it more explicitely and more bluntly, since National Defense is nothing more than the ability to wage war, if we must, it is necessary to understand at the outset the fundamental part played by TERRAIN CONDITIONS in WAGING WAR. This can be done by examining a concept of what is WAGING WAR by one of the most able of military writers and thinkers, General J.F.C. Fuller. In "Machine Warfare" beginning Chapter VI, he says:

"THE OBJECT OF ALL MILITARY ORGANIZATION IS TO ENABLE THE PRIMARY TACTICAL FUNCTIONS ACCORDING TO THE CIRCUMSTANCES OF THE MOMENT, TO EXPRESS THEMSELVES IN THE MOST EFFECTIVE WAY; and though the organization of a present day army is exceedingly complex, these functions remain SIMPLE and INVARIABLE.

"To understand what they are, all that is necessary is to reduce the battle, the central act of war- to its simplest form, and then observe what happens. When two men fight, whatever the stake may be, they have to guard, to hit and to MOVE. Whether they are armed or unarmed, or whether they are fighting on foot, on horseback or from within MACHINE, THESE THREE FUNCTIONS REMAIN CONSTANT. Multiply the two men to any number and the result is EXACTLY THE SAME. Therefore, it follows that all organisation to be tactically efficient, must express these three functions, and the more readily, rapidly and effectively it does so, the more perfect it is in itself. ... out of their combined use, TACTICS, or the ART OF FIGHTING, is evolved." (Capitals used for emphasis, not the author's but the Project-Director's).

TO SUM UP:

Two Men Fighting Need	Two Armies Fighting Need
To Guard	Protection
To Hit	Weapons
To Move	Means of Movement

Now, VEGETATION may be concerned in all three of these elements of TACTICS; for

It may function as cover or concealment or even shelter to one or both opposing armies,

It may function as cover or concealment or even shelter to their weapons,

It may retard or accelerate movement of armies and

It may indicate roughly the extent to which the soil and/or subsoil underneath it, retard or accelerate movement.

This last point is the principal object of this research. However the other points mentioned may be properly included in "Terrain Conditions" in its widest sense and are considered here but as of secondary importance in this project.

Now according to General Fuller (op. cit.) there are:

Three forms of movement: human, animal and mechanical.

Three mediums of movement: earth, water and air.

Three dimensions of movement: one-dimensional, along roads and railways; two-dimensional, over land and water surfaces; three-dimensional, under water and through the air.

Three types of military movement: strategical, tactical and administrative.

To these twelve aspects of movement, should be added, a thirteenth factor which modifies all of these twelve more or less profoundly; viz,

WEATHER

It may be objected that weather is not a "terrain condition", that it is better named as an "environmental factor". But, by whatever classification, weather is universally present and commonly modifies all these aspects of movement so profoundly that it would be folly to ignore it. e.g. Prolonged rainy weather turns CULTIVATED FIELDS everywhere into a morass of deep soft mud, obstructive to human, animal or mechanical movement over the ground. On the other hand, the same fields when dry would be much less or not at all obstructive to most kinds of movement .

Since cultivated land occupies roughly one quarter of the earth's land surface, and since military campaigns are fought for the most part on cultivated lands, the importance of the effect of weather needs no comment, in the matter of military movement.

Advising the interpreter always to keep in mind the effect of weather in modifying his interpretations, we revert to the consideration of the twelve aspects of movement tabulated on the previous page in so far as they may be affected by vegetation. First in order are the three FORMS of movement, viz, HUMAN, ANIMAL and MACHINE.

ANIMAL MOVEMENT

This report is very little concerned with ANIMAL MOVEMENT because modern armies have used machine-movement to supplant HORSE MOVEMENT except in rare cases.

For example, in the First World War, 100,000 French cavalrymen were worse than useless since the information from their reconnaissance maneuvers in August-September, 1914, was actually misleading. ONE single pilot with his camera operator could have done so very much better. On the other side an EVEN LARGER CORPS of Austrian and Hungarian cavalry, for all their excellent horsemanship were of practically no used in the campaign that led to the disastrous surrender at Lemberg. However, in the last World War, "there was effective use of cavalry by the Greek Army during the advance into Albania as well as by the British in the Syrian campaign." Col. S.A.L. Marshall in Blitzkrieg.

Perhaps it may be best to consider ANIMAL MOVEMENT in modern warfare as still useful where MACHINE MOVEMENT is impractical. This is often the case in regions of steep mountains. In Part III of this report, there is a treatment of such a region where WILD ANIMAL MOVEMENT and its effect in the shape of the game trails is mentioned.

Such game trails, are often the best travel routes for man and/or beast. Their relation to vegetation and their identification on photographs is treated.

The part played by vegetation in ANIMAL MOVEMENT in the tundra (e.g. reindeer sledges over slippery, wet reindeer moss) or in subarctic deserts (camels, yaks, etc. in the Mongolian desert) is not treated in this report.

HUMAN MOVEMENT

as affected by terrain conditions, especially as indicated by vegetation on photographs is discussed in many places throughout this report. The use of SNOW-SHOES for traversing bogs in summer time is discussed as perhaps somewhat of a military novelty although such a way of travelling has been in use in Quebec for a long time by lumbermen, etc. (See section: Peat Series in Part III).

Terrain conditions affecting HUMAN MOVEMENT, in the two greatest battlefields of Europe, Flanders and Poland, have always been of enormous military significance. The large areas in these countries that are covered permanently by deep mud or become such, mud in rainy weather, have always circumscribed the movement of armies. Because the natural vegetation as seen on air photography is often the best available indication of the height of the water table and hence commonly the depth of the mud, a special study of subarctic lowlands has been made, using as a test location the lowlands of Canada, west of James Bay. (Part III of this report). In addition the recognition of marshes or bogs and swamps on photographs is discussed in every other part of this report.

The significance of the vegetation of a marsh as a rec-

The significance of the vegetation of a marsh as a recorder betraying all HUMAN MOVEMENT as lines or trails on a vertical photograph readily detectable by the photo-interpreter is pointed out in Part II, section 6, page 5. We can therefore lay down the principle that vegetation not only indicates to the photo-interpreter the depth of the mud in the marshes but also betrays military movements in it. Further, that the more brittle the vegetation covering the marsh, the more sensitive the vegetation is in recording any movements across it by man or animals of sufficient size. By brittle vegetation is meant plants with rather thick, succulent stems like cat-tails, wild-rice, etc.

MECHANICAL MOVEMENT

Mechanical movement on wheels is largely restricted to roads and thus falls outside the province of photo-interpretation of vegetation. In modern warfare, however, CROSS-COUNTRY MECHANICAL MOVEMENT is of the greatest importance, especially movement of tracked-vehicles, tanks, etc.

To quote General Fuller again (The Reformation of War, 1922, and reiterated 20 years later in "Machine Warfare", Chapt. VIII, 1942), "The tank carries its own roadway in its tracks; it does not, therefore, need a road; it can, therefore, look upon a road or roadless country with unconcern, and in this indifference, without probing very deep, we may discover an entirely new epoch in the art of war--the epoch of roadless tactics."

That this is not an exaggeration, is explained by the General (op. cit. Chapt VIII) "The point missed was this: Should the line be penetrated, as tanks are not tied to roads, once a number have passed through the gap, by wheeling right and left and then swarming over the open country in the rear of the fortified line that line can be taken in reverse. To counter this, a very different protective system was required-namely area in contradistinction to linear."

MECHANICAL MOVEMENT IN ROADLESS TACTICS

is always restricted by terrain. "In considering the German advance into the Sedan lowland, the maneuver which punctured the paper bag of the French defense and produced the military collapse of the democratic alliance, one is impressed forcibly by two facts: THE NIGH-COMPLETE CONTROL BY TERRAIN OVER THE OPERATIONS OF LIGHTNING WAR AND THE RELATIONSHIP OF GERMAN TACTICS TO THE DESTRUCTION OF THE OFFENSIVE MATERIALS OF THE ENEMY." (Col. Marshall: Blitzkrieg: Armies on Wheels, 1943).

From this, it is readily seen that in contemporary warfare, deducing terrain conditions from air photographs is one of the principal services expected of the photo-interpreter.

Referring again to the tabulation of the twelve aspects of movement (page 3 preceding) and getting down to first principles, we can now say that as regards MEDIUMS OF MOVEMENT, this project deals with only two of the three MEDIUMS OF MOVEMENT; viz OVER THE EARTH and IN VERY SHALLOW OFF-SHORE WATER. It may be well to call attention to the fact that the greatest obstruction is commonly neither earth nor water but that their formidable combination:

M U D.

Further as regards DIMENSIONS OF MOVEMENT, it should be noted that while one-dimensional movement and warfare (trench-warfare, etc.) can make excellent use of photo-interpretation of vegetation, two-dimensional mechanical warfare over land surfaces (blitzkrieg, tank warfare, etc.) frequently depends almost entirely upon the photo-interpreter's deductions as to terrain conditions (e.g. the passage of the Nazi "Blitz" across the mountains of the Serbo-grecian frontier was planned on the basis of such photo-interpretation).

To sum up, this report is designed then to help the interpreter deduce terrain conditions from vegetation shown on photographs in so far as it affects: Human, animal or mechanical movement across the surface of the earth or of shallow water or their terrible mixture MUD, in twp-dimensional (areal) even more than in one-dimensional (linear) warfare, whether for strategical, tactical or administrative purpose.

PLATES

The plates are a special feature of this report. Each plate has on it a sufficient explanation, so that any of them by itself is still a complete study, independent of the rest of the text. The continuity of the text has naturally suffered somewhat as a result of this plan, but it is beleived that the gain in adaptability more than offsets this disadvantage.

The plates were made up as independent series especially suitable for rapid reference, so that, for example, if the photo-interpreter wished information on the effect of snow seen on photographs, he could find it in the Snowfall Series of 5 plates, almost at a glance. These plates also constitute a set of quasi-standards, or solved problems, against which the photo-interpreter can match the photograph he may be attempting to interpret.

The Keys in this report have been deliberately separated from the plates because it was beleived that the photo-interpreter could most conveniently study both the plates and the pertinent keys, with both Parts open in front of him at the same time.

For several reasons it was decided to make this Technical Report a manual of self-instruction, particularly because other very important topics allow only a very short time for studying vegetation in the classes of the Photographic Interpretation Center.

This report has been put in loose-leaf form, in four binders corresponding to Parts I, II, III, IV. The arrangement is unavoidably arbitrary, but since it is loose-leaf, the photo-interpreter can rearrange any of the Parts, sections, tables, etc. in whatever order he may find most useful to himself. It was thought that this plan of assembly would increase the adaptability of this report to fit a wide variety of needs and purposes.

Tech. Rep. 6
Part 1

PHOTO-RECOGNITION

K E Y S

TO AID IN THE

IDENTIFICATION OF VEGETATION

SPECIAL NOTE ON KEYS.

These Keys are merely an aid to the interpreter in recognizing different types of vegetation. They can help him to observe, to think systematically and to correlate; THE KEYS CANNOT THINK FOR HIM.

Once a type of vegetation has been identified, if the interpreter does not already know what terrain conditions the vegetation indicates, he should turn to whichever one of the different tables lists the types of vegetation and what they indicate. These tables are mentioned in the following section along with the first principles of interpretation of vegetation. In the Introduction to Part IV there is given two special tables of indicator plants on pages 5, 6 and 7, for the indicator plants of Colorado and Wisconsin.

How these keys are made is described in Technical Report No 5, Part II, pages 9 to 23.

The number of kinds of keys possible for special purposes is very large. An example of what a multiplicity of keys would result if each special purpose had its own special key, is illustrated in Part II, section 5 of this report in the tables between pages 10 and 11.

A list of keys published in previous technical reports of this series is placed at the end of this section.

GENERAL KEY

KEY FOR PHOTO-RECOGNITION AND PHOTO-INTERPRETATION OF VEGETATION, THE WORLD OVER.

(Naturally only a very short key indicating only roughly some terrain conditions is possible for vegetation the World over. However, such as it is , in certain circumstances and in certain regions it may be helpful to the interpreter. It is therefore set down here).

1 Regions of the earth where the vegetation is wanting or practically negligible. Regions perpetually covered with ice, Antarctica, Greenland Plateau, etc. Permanently snow-capped mountains, extreme or true, hot, dry deserts, as much of Sahara, Arabia, Death Valley, parts of Western Australia, parts of the Kalahari Desert, and cold dry deserts, e.g. parts of Mongolia, Tibet, northeast tip of Greenland, etc. roughly one-third of the land surface of the earth.

1a Regions of the earth where there is vegetation discernible especially on air photography 2

GENERAL KEY

(continued)

2 Areas evidently cultivated or formerly in cultivation, recognizable by artificial outlines, buildings, roads, etc. Usually one of the most readily recognizable features on an air photograph. It indicates fairly well-drained terrain (except for rice, there are no important or widespread crops that will grow on water-logged soil). Such areas in dry weather are areas of good travelling conditions, good trafficability. Such areas in wet weather are areas poor to very bad travel conditions. They are then areas of 6" to several feet of mud. Such areas must have something like a temperate climate, at least during the long or short summer, and must have at least a fair amount of rainfall during the growing season, or else they are irrigated, and then show the canals, etc. (Note: Cultivated lands are not the object of this Technical Report).

2 Areas evidently not cultivated 3
(Areas covered by tree or grass vegetation; i.e. forests, scrublands and grasslands).

GENERAL KEY (continued)

3 Vegetation principally of trees occupying originally about one third of the land surface of the earth. Areas more or less densely shaded . . . . Forests.

3a Vegetation principally of grasses, or cat-tails, or sedges or other non-woody plants although some bushes are often present. Indicates areas either too dry or too wet, or with soil too shallow for the growth of trees. Areas with relatively little shade . . . Marshes, prairies, meadows, grasslands, very recently burnt-over land.

KEY FOR RECOGNIZING VEGETATION IN THE NAHANNI VALLEY

ON PANCHROMATIC SMALL-SCALE PHOTOGRAPHY IN SUMMER.

(Based primarily on height of the vegetation, as determined by parallax on stereo pairs. Texture hardly discernible).

1 Height about 20 feet to 60 feet or taller 2

1a Height lower than 20 feet, commonly much lower . . . 4

2 Tone dark gray (spruces) 3

2a Tone light gray (Pl. M-2, 3, 4, 7, 17, 21) . . . . Aspen

3 Trees growing in depressions, around ponds often in association with the lighter-toned, feathery textured larch or in slight depressions at the foot of a slope where the run-off from the slope is apt to keep the terrain wet throughout the summer. Not nearly as common as the following tree. (Pl. M-2, 18, 19, 21, 24) . . . . . . Black spruce.

3a Trees very common on slopes, often in nearly pure stands on alluvial fans or deltas. On better-drained soil and subsoil than the preceding (Pl. M-1, 2, 3, 4, 7, 8, 9, 14, 15, 16, 17, 19, 20, 21, 23, 24, 25, 28) . . . . White spruce (two kinds).

4 Height 2 to 20 feet, bushes, plants with woody stems, much branched; texture very fine, often a zone above tree-line . 5

4a Height lower than 2 feet (many of these plants not with woody stem grass-like, moss-like with some very low bushes interspersed); texture not visible, (except on very large scale photographs) commonly forming a zone between the zone of bushes below (alders, willows and birches) and the snow above on the mountain tops 7

5 Bushes forming a zone of vegetation on slopes, most commonly above the tree-line but below the zone of grass-like or tundra vegetation, height 2 to 5 feet, the height diminishing with elevation progressively (Pl. M-1, 2, 3, 4, 5, 6, 9, 11, 13, 14, 15, 17, 19, 21, 22, 23, 24, 25) . . . . Scrub birch (Often in association with other bushes, heaths, etc. on drier terrain).

5a Bushes very commonly along streams, torrents, rivers and lakes, on borders of black spruce-larch swamps . . . 6

6 Tone relatively darker (Part III, Plates III, VII, XV, XVIII, XIX, XXIII and XXIX) . . . . . . Alders

6a Tone relatively lighter, sometimes almost white when the catkins or cottony fruits are present in abundance. (Pl.M-1, 2, 3, 4, 5, 6, 7, 8, 9, 14, 15, 16, 17, 19, 20, 21, 28, 29) . . . . Willows.

7 Vegetative cover practically white, appearing like snow. (Pl. M-1, 3, 4, 5, 11, 14, 19, 22). . . . Reindeer-moss.

7a Vegetative cover darker in tone (Pl. M-5, 6, 9, 10, 14). . . . . Tundra-or alpine tundra vegetation of grasses and sedges, mosses, etc.

[With slight modifications this key can be ajusted for montane regions anywhere in the arctic.]

KEY FOR DETERMINING BEST TRAVEL ROUTES

IN ARCTIC AND SUBARCTIC RUGGED MOUNTAINS.

(Based on the Nahanni Valley, Canada)

1 Very slender lines, often scarcely visible, often disappearing into forests and reappearing on the other side of a stand of trees. These are game trails, often the best and often the only feasible routes for walking 2

1a Broader, conspicuous objects on mosaics or air photographs 4

2 Trails prevailingly above the tree line 3

2a Trails prevailingly below the tree line often descending into swamps or bogs, relatively wide M-24,28 Moose trails.

3 Trails very slender, often ascending to highest elevations. M-28 Sheep and goat trails. (Important for look-outs and observation posts)

3a Trails broader, prevailingly and roughly following contours. M-28 Caribou trails.

4 Larger streams and rivers, more or less suitable for travel by raft or by canoes longer than 20 feet (mountain streams and torrents are almost invariably overgrown by willow bushes, light-toned on air photographs, and are about the worst possible routes of travel for ascending mountain slopes). . .5

4a Land or ice or snow 6

5 Water of rivers or streams, on panchromatic or infra red, white or light gray, indicating glacial milk, i.e. with rock flour in suspension, usually swift and dangerous streams of very uncertain flow; on hot days glaciers melt freely and give a large amount of water suddenly; on a cold cloudy day, these streams are much reduced in volume or stop running . . M-14,15,16,20. 25,29. Swifter streams

5a Water of rivers black on panchromatic or infra-red pictures, clear water, relatively free of rock-flour, relatively much less dependent on the weather. See Pl. M-21
Except at rapids, less swift streams.

6 Top of rounded ridges, upland heaths better than any of the following, Pl. M-23, 24 . . . . Relatively good walking.

6a Other topography 7

7 Medial moraines. Fairly good walking but uncommon see Pl. M-26, 27

7a Ice fields. Fairly good travelling in late summer when snow has melted away. See Pl. M-10.

NOTE: With slight modifications this key will be serviceable in interpreting montane areas elsewhere in the arctic and subarctic, e.g. Kamchatka, mountains of northeast Siberia.

PROVISIONAL KEY FOR RECOGNIZING
ON SMALL-SCALE AIR PHOTOGRAPHS,
THE KINDS OF VEGETATION IN THE LOWLANDS
IN THE SUBARCTIC. (See PART III, PLATES 1 to 26).

Photo-recognition

1 Areas showing as light-toned (gray to nearly white) narrow bands paralleling the rivers with a natural growth of trees or cultivated land. . . . River banks, especially the south-facing banks, the driest areas with the best trafficability.

1a Areas of irregular shapes, not narrow light-toned bands paralleling the river 2

2 Tone of area, dark gray; seen to be forest-covered under stereo. Swamps, i.e. wet forests of cone-bearing trees, i.e., spruce, fir, larch and cedar. . . . . . In this area, overwhelmingly a forest of nearly pure (B) black spruce.

2a Tone of area light to very light gray . . . (Z) Marshes, i.e. tree-less, wet grasslands.

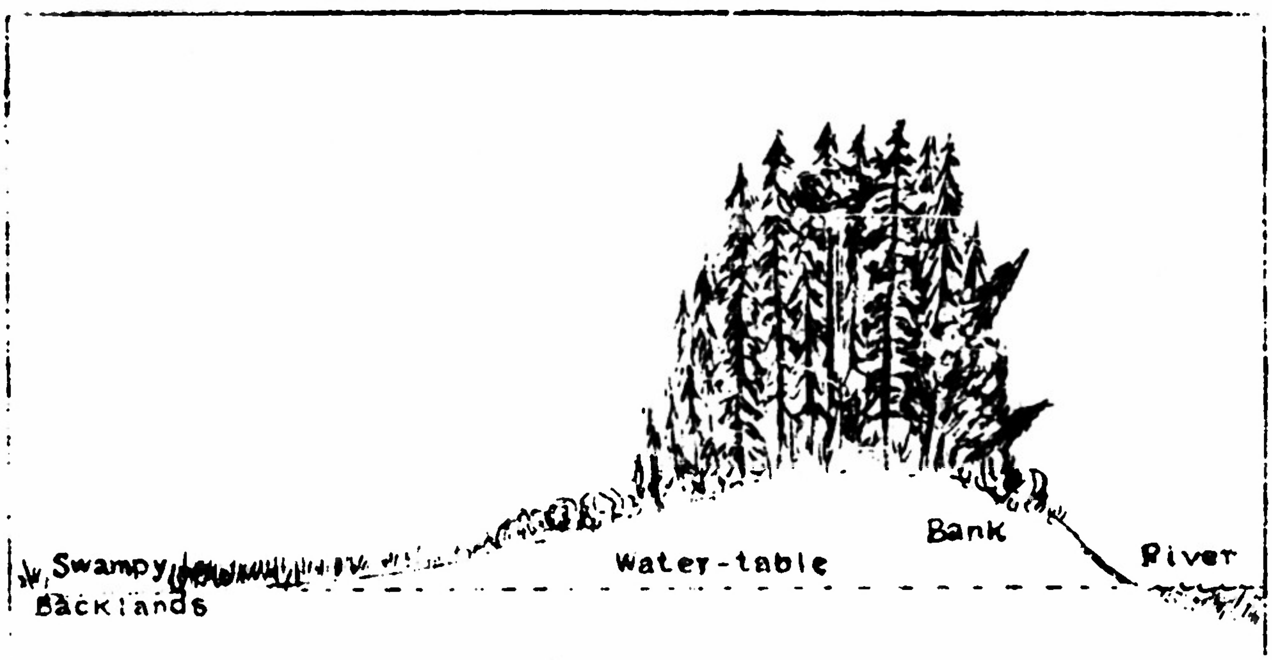
Photo-interpretation

These three types of vegetation indicate the following trafficability:

River banks--best trafficability on land in the summer, poor trafficability during spring thaw and floods, not used in winter because the adjacent ice-covered river is so much better.

Swamps--poor trafficability all the year round. Of importance as a scurce of logs for building corduroy roads.

Marshes--worst trafficability in summer; treacherous trafficability in winter except frozen solid. They contain practically no road building materials near feature.



Cross-section showing typical natural levee-like banks of rivers in subarctic lowlands.

KEY FOR IDENTIFYING THE KINDS OF VEGETATION FROM STEREO INFRA RED AIR PHOTOGRAPHS OF NORTHERN WISCONSIN, IN SUMMER.

(approximate scale 1/17,000)

1 Vegetation relatively light-toned, with deciduous leaves 2

1a Vegetation relatively dark-toned, conifers with evergreen leaves (except the larch or tamarack, the lightest-toned of these types of vegetation) and cone-shaped crowns . . 5

2 Vegetation about 3 to 10' tall 3

2a Vegetation about 10 to 100' tall 4

3 Vegetation, the zone nearest the water, usually less than 3' or 4' tall . . . . Marshland (W-25)

3a Vegetation, usually the second zone inland from the water. Alder and willow bushes about 5' to 10' tall. Water table at the earth's surface . . . . . Lowland brush (W-26)

4 Vegetation on the lowest land, usually the zone next to the ponds and marshes. Indicates wet terrain. . . . . Swamp Hardwoods (W-9)

4a Vegetation on higher ground . . . Aspen W-1, W-2; White birch W-3 & W-4; Northern Hardwoods W-5, W-6, W-7; Scrub Oak W-8.

The separation of these types of woodlands requires considerable practice.

5 Vegetation darkest in tone, on very dry situations with marshes and ponds lacking. This plant indicates the very best trafficability locally . . . Jack Pine W-15, W-16, W-17

5a Vegetation not quite as dark in tone as the preceding, in situations from moderately dry to wet . . . . . . All the other conifers

(The separation of the other conifers on this small-scale summer photography requires practice. Recognizing the associated landforms and patterns of vegetation is of great assistance in this type of photo-interpretation).

KEYS IN PART II, SECTION 5,

pages 11 to 18,

OF THIS TECHNICAL REPORT NO 6

Keys for the Recognition of Types of Vegetation and Related Landforms on Air Photographs in the Chesapeake Bay Area. A "test-location" for drowned rivers or embayments and their related types of vegetation.

KEYS IN TECHNICAL REPORT NO 5, PART II.

Keys for identification of kinds of vegetation in northern Ungava. A "test-location" on a shield area showing arctic and subarctic vegetation. This type of key with some appropriate modification will probably serve for the rough identification of vegetation as an indicator of terrain conditions in many other parts of the northern or colder subarctic region and arctic, especially in shield areas, <u>of mostly glacial erosion</u>. pages 23-27

Key for the identification of kinds of vegetation, Val David area, Quebec. A "test-location" on a shield area, mostly of glacial deposition. Especially for use

KEYS IN TECHNICAL REPORT NO 5, PART II.

(concluded)

KEYS IN TECHNICAL REPORT NO 1, PART I.

A Set of Fourteen Keys to Aid in the Recognition of Kinds of Vegetation in the Chesapeake Bay Area with Procedure for Selecting Which Key to Use.

Step 1 Determination of the Type of Vegetation by means of key on page 2	Step 2 Determination of the Seasonal Key To Be Used by means of key on pages 6, 8 or 8a	Step 3 Determination of the Species of Plant	page
WOODS	Date of photograph page 8 Photographic evidence page 6	Key No 1 WINTER	15
		Key No 2 EARLY SPRING	24
		Key No 3 MIDSPRING	25
		Key No 4 SUMMER	33
		Key No 5 EARLY FALL	39
		Key No 6 LATE FALL	43
WASTE PLACES	Date of photograph page 8 Photographic evidence page 6	Key No 7 WINTER	53
		Key No 8 EARLY SPRING	56
		Key No 9 MIDSPRING	56
		Key No 10 SUMMER	59
		Key No 11 EARLY FALL	63
		Key No 12 LATE FALL	67
MARSHES	Date of photograph page 8 Photographic evidence page 6	Key No 13 WINTER	71
		Key No 14 SUMMER	74
CULTIVATED AREAS	Not studied in this piece of research.		

Tech. Rep. 6
Part 1

PHOTO-INTERPRETATION

M E T H O D S

OF TRANSLATING VEGETATION

INTO

TERRAIN CONDITIONS

PHOTO-INTERPRETATION

Methods of Translating Vegetation into Terrain Conditions

The title of this whole Project No 257002, "Investigation of Methods of Determining Terrain Conditions by Interpretation of Vegetation from Aerial Photography", plainly calls for two distinct lines of research:

Recognition of the Different Types of Vegetation Showing on Air Photography. (see previous section).

Determining What Terrain Conditions are Indicated by Each Type of Vegetation. That is the object of this section.

PRINCIPLE NO 1. ALL PLANTS INDICATE THE TERRAIN CONDITIONS OF THE LOCALITY WHERE THEY GROW NATURALLY.

Plants can exist only within certain limits of variation of the factors or conditions of their surroundings (sometimes called "total environment" or "environmental conditions"). Hence the very fact that a plant, or better, a society of plants, exists naturally on any part of the earth implies that the factors of the environment do not vary beyond the limits within which the plant or society of plants can exist. Therefore, this plant or society of plants is an indicator of the local environment.

e.g. Cocoanut palms on a shore immediately tell us that a tropical climate exists on that shore. It also tells us however, that all the other factors of the environment, as well as their combination or total environment, are those under which the cocoanut palm can grow, e.g. the kind of soil, the height of the water-table, the amount of sea-salt in the soil water, etc. as well as all of those acting together.

PRINCIPLE NO 2. MOST, BUT NOT ALL, PLANTS EXIST WHERE THEY ARE BECAUSE THEY CAN COMPETE SUCCESSFULLY WITH THE OTHER LOCAL PLANTS, AS WELL AS SURVIVE THE CLIMATE, SOIL, ETC.

This is a very important principle for the photo-interpreter of vegetation to remember FOREVER AND A DAY. It is perhaps best explained by an example. If a southern cypress (either Taxodium distichum or T. ascendens) or a white cedar (Thuja or Chamaecyparis) is transplanted from their native swamp to much drier soil, or if the swamp is drained, these trees will grow two or three times as fast.

If however the cypress or cedar is transplanted into a dry oak woods both will die in a very short time. This is plain evidence that the cypress and the cedar grow in swamps because there the other trees cannot compete with them or grow under such adverse conditions. But the cypress and the cedar can grow very well on dry soil but they CANNOT COMPETE with the other trees, the oaks on the dryland.

On the other hand, if a black jack oak (Quercus marilandica) is transplanted from dry hill-top into AN OPENING in a cypress or cedar swamp it will die in a short time. This shows us that the oak cannot survive in the water-logged swamp soil and that it is the soil conditions and NOT COMPETITION WITH THE CEDAR or the cypress that causes this oak to be absent from these or any other swamps and that wherever this oak grows, there can be presumed dry soil. In fact, wherever these oaks are numerous on the hill tops of the District of Columbia and adjacent Maryland, a deposit of (Pleistocene) coarse gravel about 10 or more feet can be presumed (and therefore "good all-weather trafficability" the year round).

The interpreter will do well to consider another example of this kind. A year after an oak or pine forest is cut down or burnt over, a swarm of weeds, grasses, etc. appears. After a few years (about 10 to 20) the young pines will have taken possession and the weeds and grass will have disappeared. This shows us that the WEEDS AND GRASS CAN GROW ON SUCH SOIL VERY WELL but that they CANNOT COMPETE WITH THE PINES AND OAKS (i.e. they cannot grow in the dense shade created by the pines and oaks as they grow above them).

Another example

A curving line of willows in a distant meadow, is commonly taken to indicate the presence of a stream.

This is usually the case. On this account it is commonly inferred that willows require very much water and can only grow in wet places. As a matter of fact the willow trees grow very well on dry hill tops when they are planted there in the open. If they are planted under the shade of the oaks, the willows soon die. From this, it is plain that willows grow along streams in the meadows NOT because they need excessive amounts of water but because they NEED FULL SUNLIGHT(i.e. "SHADE-INTOLERANT".)

This principle OF THE FACTOR OF COMPETITION has been stressed because it furnishes the true explanation of certain seeming inexplicable contradictions in the interpretation of vegetation of great importance in the subarctic. An outstanding case of this is the question: What terrain conditions are indicated by the black spruce?

In northeastern Pennsylvania the black spruce grows only in sphagnum bogs along with the larch. In the belt of forest of the Great Lakes Region and adjacent Canada from Minn. to Maine, the black spruce is usually found in or near such bogs or wet lowlands. In Alaska the black spruce while commonly found in or near such bogs also occurs rather commonly on relatively dry, well-drained glacial till. In much of Labrador and Ungava the black spruce, and to lesser extent, the larch is found growing on relatively dry terrain. Does this mean that the black spruce is a misleading indicator plant? Or even worse, does it mean that all indicator plants are unreliable?

The solution of this difficulty is that in the southern part of the subarctic forest the spruce cannot compete with a considerable number of other trees on the drier land. (These other trees however cannot live in the water-logged, acid soil of the bogs or at least cannot compete with the black spruce there). In the northern part of the subarctic forest, in Labrador, the black spruce and the larch have no competitors and so they grow on relatively dry sites. The black spruce then can be taken as an INDICATOR OF BOGS and permanently wet soil in the southern part of the subarctic forest but as an indicator of either wet or dry soil in the northern part of the subarctic forest. It can be taken for granted that a species with such an enormous range (Labrador to Bering Strait) must have many local races with possibly varying habitats and also that it may hybridize with its close relative and common associate the white spruce. This may explain some of puzzling behavior of this spruce in Alaska and the Canadian Rocky Mountains. This does not lessen the value of the black spruce as an indicator for making rough estimates of the terrain conditions. It does require though that the photo-interpreter keep this principle, in mind, i.e. effect of competition in making his interpretations.

This same principle explains why the larch along the Larch River in Northern Ungava was found and photographed by us, growing on a dry dolomite slope (Mt. Dolomite. See Technical Report No 5).

The principle of competition comes into play in interpreting vegetation in any part of the world whenever the native vegetation is destroyed by fire, the ax, landslides, insect pests, etc.

This effect is most marked when a forest or stand of trees is completely killed, root and branch. In such cases, the total environment has changed principally in that a shaded area, is now one of full sunlight. Consequently any plants which can grow in such a soil will invade at once if the parent plants are nearby and the wind or the birds or rodents, etc. will transport their fruits and seeds into the area now open for colonization. Without this explanation, the photo-interpreter will be puzzled to find single specimens or even stands of young saplings of swamp trees growing on relatively dry slopes. e.g. the river birch and the red maple are trees commonly found in swamps especially in the coves of the Chesapeake Bay. But, sometimes, a few years after a severe forest fire killing nearly all the trees in an oak forest or pineland, a considerable percent of the new young trees may be the river birch. In the course of years, perhaps even a century, the birches will gradually die out in the fierce day-and-night competitions with the oaks and hickories.

This appears to complicate matters hopelessly for the P.I. Here is a swamp tree, the river birch, growing beautifully, on a hill. How can such a tree be reliable indicator plant?

However the interpreter should remember that this sort of invasion of dry sites, after a fire, by swamp trees is the exception, not the rule, and that such a dry site shows more or less clearly that it has been fire-swept. Further the plants that usually invade the great bulk of a burnt area are not swamp plants. Some of them are so commonly found the year after a fire that they are named after this habit, e.g. the fireweed (Epilobium angustifolium) throughout the forest region of the northern states, Canada and Alaska. (See Part I, Pl. OC 1 and 2)

The commonest invading trees after a forest fire, in most of the forests of Alaska, Canada and the northern U.S., are one or more species of poplar and one or more species of birch, etc. But especially common is the quaking asp (Populus tremuloides) considered to be the most common tree in North America. (See Part IV, pl. W-1 and 2; Part III, Pl. II, III, IV, VI, VII, VIII, etc.; also A-3, no 13-9, 13-3)

To sum up, when native vegetation is destroyed, new plants and a new vegetation invade even where the stumps and roots send up fast growing shoots which soon shade out the invaders. In general the invading vegetation can be used to deduce terrain conditions provided that the interpreter RULES OUT SUCH PLANTS AS CAN GROW ANYWHERE BUT ARE LIMITED BY COMPETITION WITH OTHER PLANTS. Usually these are plants which commonly live in an extreme or specialized type of habitat, more or less inhibitive to plant growth, such as, a high acidity (of bogs) the high osmotic pressure of the salt water (of lagoons,) etc. At any rate, the P.I. should never base an interpretation of terrain conditions on a single plant but rather on the pattern of vegetation and the plant society.

PRINCIPLE NO 3. THE TERRAIN CONDITIONS INDICATED BY BOUNDARY LINES BETWEEN ZONES OF VEGETATION ARE OFTEN RECOGNIZABLE OR EVEN OBVIOUS ON PHOTOGRAPHS.

The previous 2 principles, probably the most fundamental for the photo-interpretation of vegetation, show in what way any and every individual plant is an indicator of terrain conditions. This principle No 3 deals with groups or societies of plants or large, essentially pure stands of one plant, especially as regards the lines that form the recognizable boundaries of such societies or zones on photographs.

a) ARTIFICIAL PLANT SOCIETIES OR MAN-MADE ZONES OF VEGETATION

These areas of cultivated land are usually easily recognizable by their more or less regular or artificial-looking boundaries and the associated artifacts, roads, buildings, irrigation-ditches, rows of trees in orchards or plantations, rows of crop-plants, etc. Such areas are not included in this Project.

However, they do indicate at least one very important fact, i.e. they are never permanently water-logged areas (rice-fields excepted) and therefore in dry weather have at least fairly good travel conditions. BUT after a notable rainy spell, practically all cultivated fields become layers of mud or soft silt from six inches to several feet deep. Exceptions to this rule are: fields of almost pure sandy soils or of soils with a very high content of gravel.

Such soils may actually become firmer with light rains and, even after heavy rains, may still be not muddy and relatively much firmer than clay or silt soils.

b) WASTE PLACES

These are plant societies that invade cultivated fields that have been abandoned. Many of them are the familiar WEEDS, not only, small weeds such as, dandelion, garlic, milkweed, thistles, etc. etc. but weed trees and bushes, such as the Ailanthus or Tree of Heaven (it smells like H-, I mean the other place) so very common on trash dumps and waste places around our eastern cities and towns as well as in China, Korea, etc., the original home of this tree. An example of a weed bush is the Scotch broom in Oregon.

Generally waste places show some signs of having once been cultivated signs usually more easily recognized than described. Naturally such waste place-vegetation or weeds and/or other invading indicate the same terrain conditions but often somewhat better as regards the firmness of the soil since the loosely plowed soil tends to become at least slightly more consolidated. In general then, waste places afford fairly good travel conditions in dry weather and bad to very bad in wet weather.

C) NATURAL VEGETATION

This can usually be recognized as such because it shows none of the customary easily recognizable signs of having been cultivated. By means of the stereoscope, it is possible to recognize on all but very small-scale photographs, three great types of vegetation on the basis of height. These are:

Grasses, sedges, and other non-woody plants, herbaceous i.e. non woody vegetation.

Bushes or shrubs.

Trees.

A rough estimate of the amount of the earth's land surface covered by vegetation is:

one third covered by natural grasses, i.e. treeless country, e.g. the true arctic, not permanently covered by ice, the short grass prairies of U.S., the steppes of Russia and Siberia, etc.;

one third covered by natural forest land;

one third covered by ice or deserts, i.e. with vegetation of essentially no significance in ordinary photo-interpretation.

In dealing with grass-vegetation, bush-vegetation and tree-vegetation, it is useful to understand why each of these main types prevails where it does, at least in a rough way. It may be stated thus: Grasslands are treeless because:

a) they do not receive enough rain e.g. steppes of Russia, grass prairies of U.S.

b) they do not thaw deep enough in the summer (or do not have a warm summer long enough to mature seed? or?) as in the arctic region (or tundra in its widest sense);

c) or because they are permanently too badly water-logged and/or have water which is too highly acid to permit tree growth, e.g. many sedge marshes, peat-bogs, etc.

d) or because they are not only permanently badly water-logged but have such deep soft bottom as to offer insufficient anchorage for tree growth, e.g. the Everglades of Florida where the soft peat bottom may be 10' to 20' deep.

The photo-interpreter, knowing the climate, locality and other circumstances of a region, can often decide in each case what terrain conditions are indicated by a natural grassland, (and the corollary, the natural lack of trees). Sometimes this is evident from the photograph itself, e.g. Plates C-1 to C-4 (in Part IV)(showing the vegetation in Colorado) show trees in ravines and only on some slopes and less vegetation in the low-lands than in the mountains. Obviously this must be a region of small rainfall and is tree-less for that reason since the trees are found only where the water can collect, (i.e. in gulleys) or where the small amount of rain first falls, e.g. near the tops of the mountains or on the sides of the mountains facing the rain-bearing winds. Hence, the absence of trees in a region indicates terrain conditions just as does the presence of trees, as is explained next.

Natural Bush-lands or Scrub-lands or open thin forests of small trees indicate usually a deficient rainfall or a soil too thin or too poor in water-holding capacity to support tree growth but yet holding enough water to allow bushes and/or small trees to grow there. In the arctic regions, on "bush-tundra" the presence of bushes (alders, willows, birches, heaths, etc.) usually indicates deeper thawing and better underground drainage than in the adjacent sedge marshes, peat moss bogs, etc.

VARIOUS KINDS OF TREE-LINES AND THEIR SIGNIFICANCE

The presence of a forest but more especially the boundary of the forest or stand of trees, THE TREE-LINE, indicates many terrain conditions. These indications may be stated as follows:

1. A relatively warm summer long enough for tree growth. The absence of trees in the arctic indicates a cold, cloudy summer.

2. The presence of trees indicates nothing as regards WINTER TEMPERATURE.

3. The presence of trees does not indicate whether or not the subsoil is permanently frozen at depths of about 2 or more feet.

4. The presence of trees does indicate that the ground thaws in summer to a depth of roughly one foot, commonly more than two feet.

5. The elevation above sea-level of a tree line in a country, taken in connection with its latitude, gives an indication of the summer climate, e.g. In Great Britain the tree line is at an average elevation of 2000 feet; in Switzerland, the trees ascend on some slopes to about 6000 feet while much farther north in Alaska under the Arctic Circle the tree line is at roughly the same elevation as in Great Britain. In the Ural Mountains the elevation of the tree line is much as it is in Alaska. This is due to the cold cloudy summers in the mountains of the British Isles and the warm sunny summers on the mountains of Switzerland, Alaska and the Russia.

PATTERNS OF VEGETATION.

The order or arrangement, more or less concentric, of zones of vegetation is very significant and is a safeguard in interpreting if properly used. One order of zonation that is very common can often be located by starting with a body of water, i.e. a stream, pond, lake or seashore.

This pattern of vegetation, in order from the wettest to the driest may be put in this general form:

1. Water;
2. Herbaceous zone-grasses, sedges, cat-tails;
3. Bushes, e.g. alders;
4. Swamp Trees, e.g. red maple, larch;
5. Rich Moist Woods Trees, e.g. tulip tree, beech;

6. Dry Rich Woods Trees, e.g. white oak, sugar maple;

7. Very Dry Barrens with Sparse Trees, e.g. blackjack and other scrub-oaks.

If such a set of zones of vegetation occurs on flat or gently sloping terrain, each of the zones will be broad.

If the slopes are steep, the zones will be narrow; if the slope is very steep or precipitous, some or all of the intermediate zones may be omitted.

This principle can be used to make several important deductions, e.g. if the zone of cat-tails is wide, the bottom of the creek or river must be very flat (e.g. Part II. Photographs 12-5). If further inland the zone of bushes is narrow (e.g. same photograph) the banks in contrast must be steep.

MARSHES ARE AREAS FOR

"FINGER-PRINTING", MOVEMENTS OF THE ENEMY.

Because marshes are tree-less, they are peculiarly favorable for making vertical air photographs. Because much of the vegetation in marshes is brittle and breaks or folds down very easily, the readily betray any movements of man or large animals across them. Hence, such an area cannot be crossed by a single soldier, mines cannot be laid in it, barbed wire not placed in it, vehicles not run it, without flagrant betrayal of what has taken place on a vertical air photograph.

DEDUCING THE STABILITY OF A TALUS SLOPE

FROM VEGETATION

Vegetation can be used to deduce the stability of a talus slope. The denser the vegetation, the more stable the talus. A talus slope devoid of vegetation is still in an unstable or sliding condition.

DETECTING THE PLACES WHERE MOSQUITOES BREED.

Most of the blood-sucking insects have an aquatic stage early in life, usually after the egg hatches. This usually in stagnant shallow water. Hence, vegetation associated with such water can be used as an indicator of potential mosquito breeding places.

DETECTING THE PLACES WHERE BLACK-FLIES BREED

Since the aquatic stage of most species of these insects is passed in well oxygenated water, the vegetation associated with swift-flowing streams helps to locate their breeding places when it is planned to wage war on them (e.g. see Part III, Plate M-12, 67-4, 5 and 6).

AREAS INFESTED BY VARIOUS TROPICAL DISEASES

CAN SOMETIMES BE DELIMITED ON AIR PHOTOGRAPHS

In Siberia, the dry grass lands(elephant-grass, etc.) can be recognized. They are not breeding grounds for mosquitoes and therefore tropical malaria.

Areas where the tsetse fly breeds and also where it harbors can also be delimited in Tropical Africa. This is an important means of controlling the dreadful disease, sleeping sickness. The tsetse fly harbors in mangrove swamps but breeds further inland along a narrow belt of bushes and trees on river banks. Both these types of vegetation can be detected on air photographs. Similarly the ponds in which the tropical snail that carries the disease Schistosomyasis can be recognized as such, fairly well, by the vegetation on the borders of these ponds in Western Africa.

CLIMATIC FACTORS CAN BE DEDUCED FROM PHOTOGRAPHS.

Pl. II shows how direction of prevailing or strong winds and depth of snow in winter may be deduced.

LOCATING ROAD BUILDING MATERIAL BY MEANS OF THE VEGETATION SHOWN ON AIR PHOTOGRAPH.

This topic is illustrated by Plates I, VII and VIII.

Time and space make it impossible to include in this Report many more generalizations which the Project Director hopes to study more fully and present later in a future publication, e.g. in general, the pines as a group always signify drier terrain than the spruces or larches or firs. This applies to the forests of Siberia, Russia, Finland and Scandinavia as well as the forests of Alaska and Canada. (Note that the "Scotch fir" of the British Isles is the Scotch Pine of this country [Pinus sylvestris]).

Another generalization on which the Project Director hopes to continue working is the determination of the degree of similarity of zones of vegetation in the Old and New World arctic and subarctic regions. This similarity has been known in a general way for a long time, e.g. J. C. Brown, (Edinburgh, 1884) in "Forests and Forestry of Northern Russia", writes:

> "If from the base of some lofty range of mountains in a tropical land, which, notwithstanding the high temperature in the plain, have their summits covered with perpetual snow, we ascend to this cooler region, we shall find vegetation of one kind giving place by degrees, tropical plants giving way to others, and these again to others, and such changes repeating themselves till at length we meet only with lichens and mosses and their allies. And like changes in the vegetation might be observed if we journeyed from the equator to either pole, representative of the successive zones on the mountain. Of this successive disappearance of different kinds of plants, as a mountain rises in altitude, Lapland supplies many illustrations. Baron von Buch writes:—
> 'It is extremely entertaining to climb great and rapidly ascending heights in these climates. The vegetation with which we are familiar in the valleys gradually disappears under our feet. The Scotch fir soon leaves us; then the birches become shrivelled; now they wholly disappear; and between the bushes of mountain willows and dwarf birches, the innumerable clusters of berry-bearing herbs have room to spread—blae-berries on the dry heights, and mountain brambles on the marshy ground. They at last appear singly, with few leaves, and no longer in a bushy form. At last they disappear, and they are soon followed by the mountain willows. The dwarf birch alone braves the height and the cold; but at last it also yields before reaching the limit of perpetual snow; and there is

a broad border before reaching this limit, on which, besides mosses, a few plants only subsist with great difficulty."

The similarity of the order(or pattern) and the content of these Russian montane zones of vegetation to those in Canada and Alaska is very striking .

"On Akka Solki, one of these mountains on the western coast, which is about 3392 English feet in height, the following limits of the different productions were accurately marked:

	Engl. Feet.
Limit of snow in latitude 70°	3514
Betula nana, or dwarf birch, ...	2742
Salix myrsinitis, or whortle-leaved willow, .	2150
Salix lanata, or downy willow, rises above the Betula nana, and approaches the limit of perpetual snow, ...	
Vaccinium myrtillus, or blae-berry, ...	2031
Betula alba, or birch tree, ...	1579

We should find following each other in the same order, but in broader zones, in the tropical, sub-tropical, temperate, and arctic or antarctic regions of the globe, many of these zones being susceptible of well-defined sub-divisions."

In the foregoing, J.C. Brown (1884) has expressed very well the notion of zones and patterns of vegetation for the entire world, and thus the basis for this important principle in photo-interpretation.

REFERENCE LIST

Indicator Plants and Plant Societies,

And What They Indicate.

(Lists in other Technical Reports of this Series, and in Part II of this Report No. 6 .)

Technical Report No. 6

Tables of Types of Vegetation and What Terrain Conditions They Indicate. Part II; section 7, Table No.1

Tables of Principal Plants and What Terrain Conditions They Indicate. Part II; section 7, Table No.2

Technical Report No. 5

Chart: Vegetation as an Indicator of Terrain Conditions in the Arctic and Subarctic Regions, arranged in approximate order from the driest and best trafficability to the wettest and worst.

Some Important Indicator Plants of the Arctic And Subarctic Regions, and What They Indicate as to Terrain Conditions. Part III

Tabulation of Arctic and Subarctic Plants of the Kaniapiskau area, and What They Indicate as to Terrain Conditions. Part IV; Table No. 1

REFERENCE LIST

(continued)

Table, Showing in Three Parallel Columns, Plants most Commonly Found on a) Hills and Uplands; b) Slopes and Lowlands; c) Marshes and Swamps. Part IV; Table No. 2

Technical Report No. 1

List of Important Chesapeake Indicator Plants and What They Indicate (See also Part II pages 1 to 11 .) Part IV

Generalizations: Photographic Technique Part II page 11

Generalizations Based on Characteristics of the Individual Plant as a Whole. Size; Shape; Habit; Abnormal Shapes; Roots; Trunks; Limbs, branches, twigs; Leaves, leaves and wind; Special Notes on Effect of Leaf Characteristics of Deciduous Vegetation on Photo-Interpretation; Winter Aspect of Deciduous Trees and Shrubs. Part II, pages 13-20

Generalizations Valid for Deciduous Forests in the Entire Subarctic and Temperate Regions (and probably to a Considerable Extent in Deciduous Trees and Shrubs in the Tropics and the Tundra. Part II, pages 20-23

Generalizations Based Upon Systematic (Classificatory) Botany of Use in Photo-Interpretation. Part II, pages 23-27

REFERENCE LIST

(continued)

REFERENCE LIST
(continued)

Tech. Rep. 6
Part I

INTERPRETATION

of

COLOR TRANSPARENCIES

Use of Variously Colored

Light in the Light-Table

Improvising

Variously Colored Filters

for

Studying Transparencies

Samples

of

17 Kinds of Paper

of

Different Colors and Thicknesses.

INTERPRETATION OF COLOR PHOTOGRAPHY

A question often raised is:
Of what practical military use is color photography? What advantages does color photography have over panchromatic or infra-red photography, at least in so far as military photo-interpretation is concerned?

It is usually objected that color photography costs two to several times as much as panchromatic, that it does not give nearly as sharp details as black and white film, that it requires much greater time and skill to process properly and consequently poorer results are more often obtained.

It is not our purpose to discuss these points here any further than to point out that there are certain problems of photo-interpretation which can be solved more easily and more quickly by the use of color than by the use of black and white photography and that there are even certain instances where black and white photography is of no use while color photography enables the object to be recognized. The reverse is also often true, e.g. it is necessary to determine from a summer air photograph the boundary line between a beech woods and an adjacent woods of river birch,(indicating wetter terrain.) Since the birch and the beech both contain exactly the same green pigment, chlorophyll A and B color photography is often not as good as black and white.

However in the fall of the year the beech turns a conspicuous warm tan while the birch turns inconspicuously dull yellow and only on a small part of the foliage at one time. In such autumn photography color film is far superior. (Incidentally the boundary line between two such woods indicates commonly the lowest and often most convenient contour on which to build a road in the ravines near the Chesapeake Bay.)

IS THERE ANY RULE BY WHICH IT CAN BE DECIDED WHETHER COLOR OR BLACK AND WHITE FILM SHOULD BE USED FOR ANY PARTICULAR INSTANCE OF PHOTO-RECONNAISSANCE OR PHOTO-INTELLIGENCE ?

Disregarding the factor of cost, time and skill required in developing, etc. which must necessarily be decided or considered in each individual case , there is ONE PRINCIPLE which seems best to consider ahead of all others. IT is :

Which photography will give the greatest degree of contrast between the object sought and its background ? Middleton has estimated on excellent grounds that the average human eye cannot distinguish an object from its background unless it is in at least two percent of contrast with it. From this it follows that where black or white or any mixture of these two (some shade of gray) are involved, but no colored object or background, black and white film will certainly give the highest contrast. In such a case the use of color film is unnecessary. If however, either one or both object and its background are colored , color film is certain to make objects more easily visible unless the object and its background are practically the same color. When an object and its background are of different colors but the contrast between them is nevertheless lower than 2% , color photography has another advantage over black and white photography in that this contrast too small to be visible, can be made much greater, and therefore visible, by viewing the color transparency against a source of light of as nearly the same color as the object or its background as is possible or practical to obtain. The photo-interpreter is referred to Technical Report no.2 of this series where a very convenient and practical means of obtaining such a colored light is described. This is not possible in the case of black and white film.

AN EXAMPLE OF THE MILITARY USE OF COLOR TRANSPARENCIES STUDIED BY MEANS OF VARIOUSLY COLORED LIGHT .

The interpreter is asked to locate on photographs pill-boxes and machine-gun nests possibly camouflaged with branches of trees or bushes near the top of a ridge in Korea. Using a stereoscope and the utmost feasible magnification nothing is discovered on panchromatic small scale photography of this ridge. Turning now to color photography taken at the same time and on the same small scale, the photo-interpreter notices, on magnifying this film under a stereoscope, small spots of brown against the blue skyline, too small and indistinct for proper identification. He, therefore, interposes a transparent or thin translucent orange-colored sheet of paper between a source of bright light and the transparency. The sheet of paper or other improvised filter can be clipped to the transparency or held by a clamp in front of the light (e.g. in front of the brightest part of the beam from a Coleman light, sometimes supplied the photo-interpreter in the field in Korea). In this way a source of colored light is obtained which is somewhat like the color of brown leaves suspected as a possible camouflage. If the source of light is bright enough or the filter thin enough, the dead brown leaves will now stand out decidedly more brightly and clearly against a darker background than when the transparency was viewed with white light. (If the colored paper or thin cloth used is too thick to allow enough light to come through, oiling the paper or cloth will increase their transparency). When such dead-leaf-camouflage is detected, it can be verified further by using pale blue paper as a filter for areas where the brown spots appear against the sky-line and by using pale green paper where the brown camouflage spots appear against green foliage. In either case the brown spots will appear darker against a brighter background than when viewed with white light.

THE USE OF THE SEVENTEEN COMMON KINDS OF COLORED PAPER

AND INDEX AT THE END OF THIS SECTION

These sheets of paper can be used as extemporaneous filters for obtaining colored lights but they are also to serve as standards of color terms, so that the photo-interpreter will have at hand at least a few sample colors designated by words as well as by a standard way of expressing color by a numerical notation (Munsell), (determined at the National Bureau of Standards). Without such a system based on physical standards, names of colors are nearly meaningless. Knowing the existence of this system, when the need arises, the photo-interpreter can in any keys or notes he makes, describe in words or notation the colors of what he sees or observes, with the assurance that his color terms can be understood. (It is extremely difficult to find any agreement among observers as to what is meant by such words as "tan" or "brown".) These seventeen sheets of paper are inserted here then in order to assure the photo-interpreter that it is possible and entirely practical to use words designating colors that will be understood and to refer these colors to definite standards which are reproducible. This is important in using terms to designate colors in any keys for interpreting color photography.

FILTER FOR DETECTING FOX-HOLES.

A Rough-and-Ready Method for Making even on the Battlefield Custom-Built Filters.

Obtain a sample of the layer of soil or subsoil, likely to be shoveled out in making a foxhole. Put a handful or a teaspoonful as is necessary, in a vessel filled with water. Allow the coarse particles to settle. Pour the muddy liquid into a bottle and add anything that will serve as a transparent adhesive, egg-white, gelatin, glue, et. Spread or paint on a thin sheet of glass or plastic. When dry this is a CUSTOM-BUILT Filter for foxhole detection in areas where soil or subsoil of such color occurs. If one layer of this "mud-paint" is too thin, another can be added. Another procedure is to evaporate the muddy water to dryness and suspend the dry fine clay in a clear varnish, shellac, "dope" i.e. any of such transparent materials as may be available. Generally most materials are too thick or contain too much color to serve as filters because they cut off too much light. When a color-transparency is viewed through such a filter interposed either between the eye and the transparency or between the source of light and the transparency, the fox-holes will appear much brighter, while the background will appear darker, unless as very rarely happens, the background is of the same color as earth excavated from the fox-hole.

ROUGH-AND READY FILTERS FROM FOOD WRAPPERS

The orange or yellow cellophane wrappings of food packages, are very serviceable filters to use in the detection of vegetation browned by man or by any other agent. Such orange cellophane or orange filters (Wratten G filter) can be used in front of field-glasses, periscopes, camera-lenses for the same purpose and will help in a similar way. This use of orange filters in front of binoculars is now a routine procedure of foresters (Forest Insect Laboratory, Beltsville, Md.) for detecting dead brown pine trees. (See Section on Browning of Vegetation, Plates NY-1, 2, and T-1 to T-4).

In Technical Report No 2 (Confidential) of this series, the Project Director has discussed this method of photo-interpretation from other specific military aspects. Report No 2 contains numerous other ways of improvising color filters. This topic has been introduced here deliberately as means of training the interpreter to think in terms of color photography as well as for the specific military objectives mentioned. It seems highly desirable to make the photo-interpreter as resourceful as possible. To make a good interpreter he must learn to think out each problem by itself, if need be, making use of what general rules he has learned.

The importance of color in camouflage and of its detection by color photography has long been recognized. Thus, Walter Kerr in "The Russian Army" (Chapter 9, 1944) writes:

"Great attention was paid at all times to camouflage. The paths were carefully covered with grass and leaves. Branches hid the guns that were partially buried in pits. Men in OBSERVATION POSTS were either underground or wearing GREEN AND BROWN CLOAKS and Hats to blend them into the background."

Further information of recent developments in Color Photography particularly in the USSR may be obtained as a microfilm copy of a negative in the Library of Congress:

K. Merttъ: Цветная Фотография. Москва, Госкиноиздат, 1950.

Title transliterated: T͡svetnai͡a fotografii͡a.

(Mic 52-646)

Tech. Rep. 6
Part 1

INDEX

TO THE FOLLOWING SEVENTEEN SHEETS

OF COLORED PAPER

Trade Name	Munsell Notation	Inter-Society Color Council and National Bureau of Standards Name
	Mimeo Bond Paper	
Blue	1. PB 8.6/3.7	Very Pale Blue
Tuscan	7.5YR 8.3/6.3	Light Orange Yellow
Green	5. G 8.7/4.3	Very Light Green
Orange	9. YR 7.8/12.	Strong Orange Yellow
Pink	6. R 8.5/5.	Light Pink
Dull Yellow	3. Y 9.2/6.5	Light Yellow
Bright Yellow	7.5Y 9.2/6.5	Light Greenish Yellow
	Onion Skin Paper	
Blue	10. B 7.6/4.	Very Pale Blue
Green	5. BG 6.7/3.7	Light Bluish Green
Orange	1. YR 7.2/8.7	Strong Yellowish Pink
Pink	8.5RP 7.4/8.5	Moderate Purplish Pink
Canary Yellow	8. Y 9.1/6.	Light Greenish Yellow
Yellow	2. Y 8.5/7.5	Light Yellow
	Bond Paper	
Blue	0.5PB 8.5/3.5	Very Pale Blue
Green	4.5G 8.8/4.0	Very Light Green
Pink	5.5R 8.5/5.	Light Pink
Yellow	8.5YR 7.6/12.	Strong Orange Yellow

R E S T R I C T E D
Security Information

Tech. Rep. 6
Part 1

MILITARY INFORMATION

DEDUCIBLE FROM VEGETATION

ON

AIR AND GROUND PHOTOGRAPHS

Locating Road-building material; Recognizing Climate;
Height of Water-table; Seasonal Aspects;
Marshes, very sensitive recorders of military operations.

Illustrated by Plates I to VIII.

R E S T R I C T E D
Security Information

REP.SIX
RT I

Gravel

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SECURITY INFORMATION

PLATE I

Locating Road-building Material From Air Photographs Using Both Landforms and Vegetation: Esker in Maine (H.W. 6-37,38. 10-15-1946, 1/17,000 approx.) Pitted Glacial Outwash, Matanuska, Alaska (22592, 22590, July 14, 1948, U.S. Coast and Geodetic Survey, 1/10,600 approx.) Steep slopes indicate gravel.

The rate and direction of movements of an army in the arctic and sub-arctic regions in the summer or season of unfrozen ground depends largely on the location of road-building material. Obviously locating surface deposits of gravel or high content of gravel is therefore of the greatest importance in planning the route of advance of an army. The stereopairs above illustrate how deposits of high content of gravel may be recognized by means of the land forms and the vegetation in many parts of the arctic and subarctic regions from Maine to Alaska, from Kamchatka to Scandinavia.

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PLATE II

Vegetation as an Indicator of Climate. Direction of Prevailing and/or Strongest Wind Shown by Unequal Length of Branches on Opposite Sides of a Tree on Ground and on Air Photographs as Asymmetric Crowns.

These photographs show the black spruce (B) near the northern limits of its distribution, i.e. the tree-line and how in these desolete situations it serves as a weather-recording instrument. 6153, 1, 3 clearly show that the prevailing strong wind is from left to right, just as 4 shows the prevailing strong wind is in the opposite direction. The spruces on 1 and 2 register the average height of the snow drifts in winter by the section of the trunk where the branches have been worn off by the fine ice driven by the winter blasts that raged above the snow. The spruces on 3 and 4 show the effect of the sand and ice blast as well as a blow-out at Port Manvers, Labrador. 6153 shows black spruce with reendeer moss (R) and heaths (H). 1 and 2 were taken at Churchill.

E: sea rye. •: height of snow drift

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Patterns of Vegetation: Zonation in the Subarctic Region. Along th Albany River and at the Mouth of the Attawapiskat River. 1952.

6081

6082

6211

A small admixture of sand and gravel makes this tidal flat passible for caterpillar tractors at low tide.

Photo-recognition of vegetation and subsequent photo-interpretation is made very much easier by taking advantage of the fact that different types of vegetation are commonly arranged in zones or bands and that relatively few kinds of plants make up the great bulk of many of these zones throughout the world. In the subarctic zone the forests or stands of trees are commonly bordered by a line of lower plants, or bushes. These are either some one of dozens of species of willows, or alders or sweet gale or shrubby birch - very rarely other shrubs in large enough quantity to show on an air photograph. Whenever a body of water is present, it is good procedure to start with water and note the bands or zones on the photograph whether horizontal or vertical. The zone closest to the water, about 1 to 2 feet tall and light toned is usually sedges, marsh grasses, reeds, etc. The next zone inland is bushes, that is, willows, alders or sweet gale or shrubby birch. Still further inland is the stand of trees. These zones correspond to a progressively lower water table or a progressively less wet conditions underfoot. 6081 shows the Albany River, the first or lowest zone (o) sedges and grasses; the second zone (S) is mostly a light-toned (Salix candida) willow bush in front of a darker taller willow (Salix pellita); the third zone (trees) is mostly the very dark-toned black spruce (B) with a few quaking asps. (Q). The larger, spreading lighter-toned trees in the background are cottonwood.

6082 Taken Aug.22, 1952 near the same spot shows all the above as marked, but in addition, at the extreme right a colony of Salix lucida rather dark-toned and at the extreme left a row of lower, medium gray-toned Sweet Gale (Myrica Gale). 6211, Sept. 7, 1952. Shows zonation on an exceptionally dry, high bank, the best farming site locally. A pure stand of (C) cottonwood (here 60' tall) always indicates well-drained soil, from Labrador to Bering Strait. M: Sweet Gale (Myrica Gale)

Keep this wide margin on this side exactly as as

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SECURITY INFORMATION

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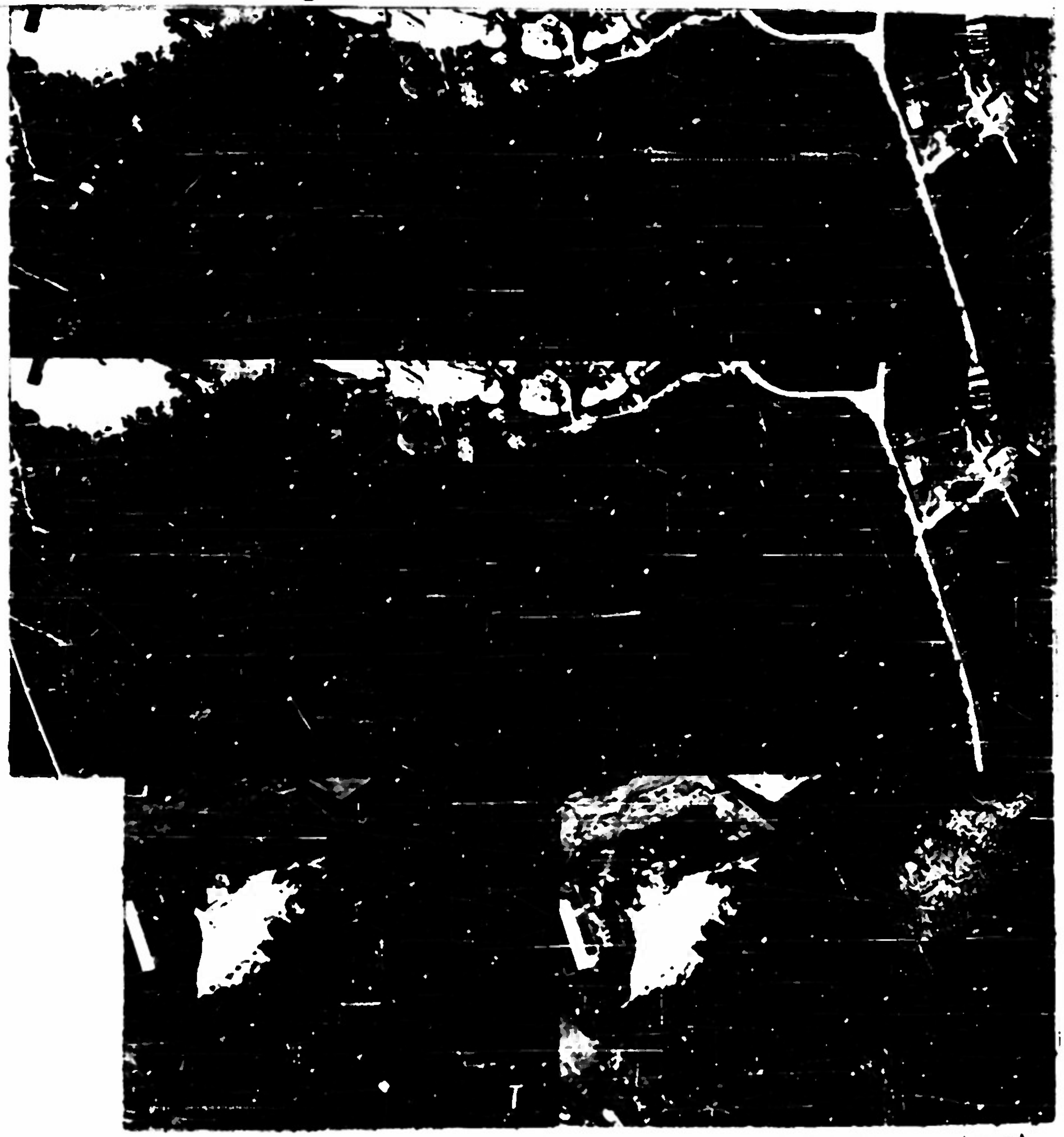
SECURITY INFORMATION

PLATE IV

Panchromatic Stereo Air Photographs 1/4800, upper June 1950, lower Dec.1950
Taken by Forest Insect Laboratory, USDA, Beltsville, Md. Showing seasonal aspects of swamp with marginal marsh



KEEP WIDE MARGIN

It is noteworthy that the marshy (tree-less) area is in much higher contrast with its surroundings in the winter than in the summer photograph. The marshy areas have deeper, softer mud than the swampy or tree covered areas.

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Trails made by man or large animals show plainly on air photographs. They should be differentiated from small channels (3690) and the workings of muskrats (3700). Since cat-tails commonly occur in pure stands, they have a distinct texture.

Cat-tail marshes are found in lowlands and flat terrain around the globe. In this hemisphere from the Gulf States to Alaska; in the Old World in Baltic area, etc. They root in mud under shallow water and indicate permanently wet areas mostly impassible by all ordinary tracked vehicles. Here is a detail of a cat-tail marsh in the Chesapeake area where the traveler, unless he steps from tuft to tuft, will sink in the mud to a depth of 2' or 3' between the tufts of cat-tails. From the standpoint of reconnaissance, a cat-tail marsh is as sensitive a recorder of the passage of man as is freshly fallen snow. Because the stalks are brittle and stay bent-down readily, a man or large animal cannot cross such a marsh without leaving a trail plainly visible on air photography.

T.REP.SIX

PART I

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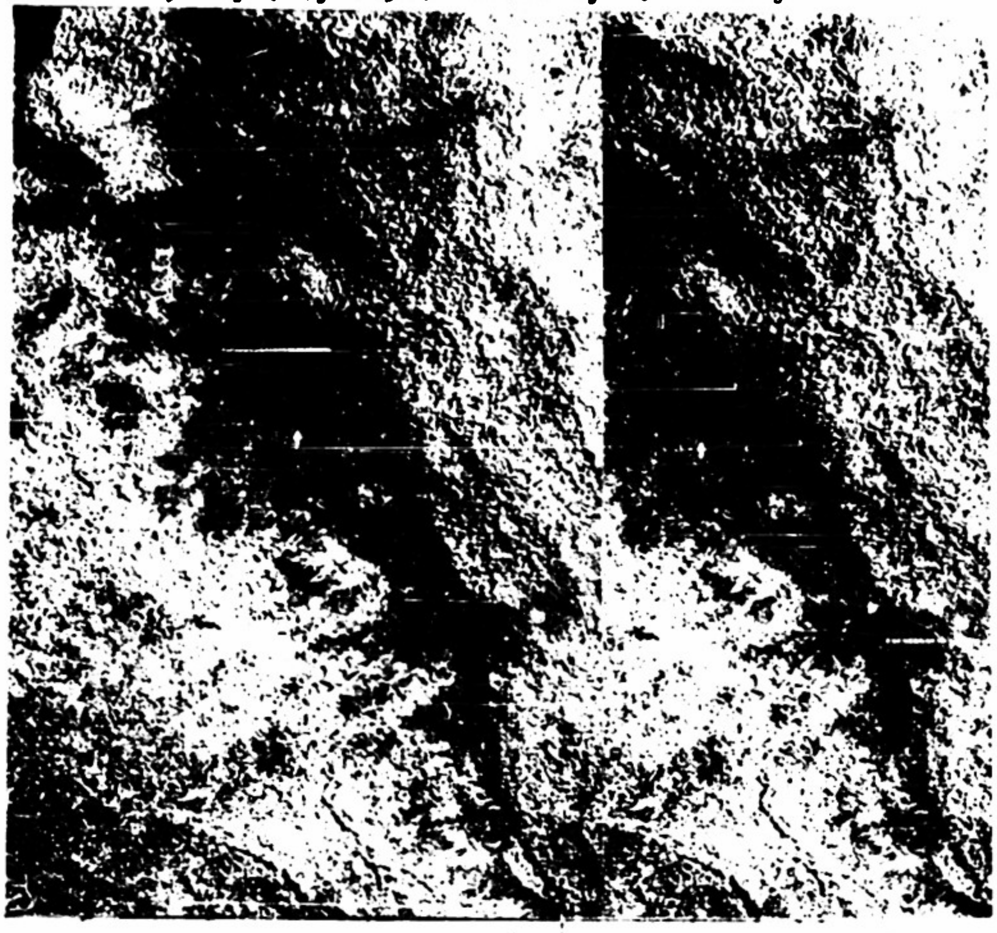
SECURITY INFORMATION

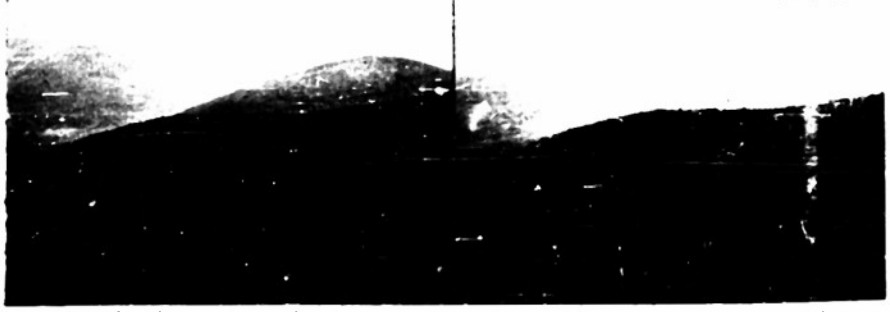
PART VI

Stereo Infra-red Air Photographs, approx. 1/17,000, H.W. 2-116, 117, showing a steep slope in Greenville Township, Maine, covered by a stand of ta red spruce (Picea rubens). Stereo Panchromatic Ground Photographs of a steep slope on Equinox Mt., Sept. 9, 1950. Taken by A. Dutilly.

KEEP WIDE MARGIN



2942b



Dr. Harold E. Young, who secured the air photographs from Maine, states that the combination of steep slope and dense growth of the dark-toned red spruce creates a very formidable obstacle to travel and lumbering, whence the name Misery Ridge. The Vermont slope, elevation 3800', is covered with a forest of yellow birch with a fair amount of fir and black spruce.

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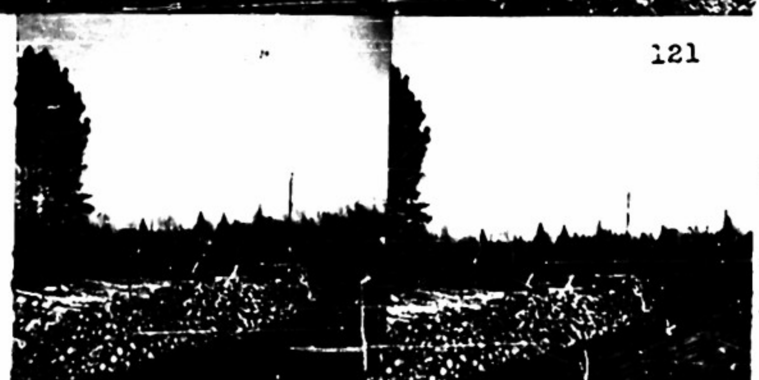
Stereo Air Photographs, in the State of Maine approx. 1/17,000, SDW-10-13, 12 showing a boom with cord wood and on an island-esker, and a gravel pit at the side of a kame, June 6, 1952; and EPW-13-18, 19, showing a boom with logs, June 6, 1951.

KEEP WIDE MARGIN

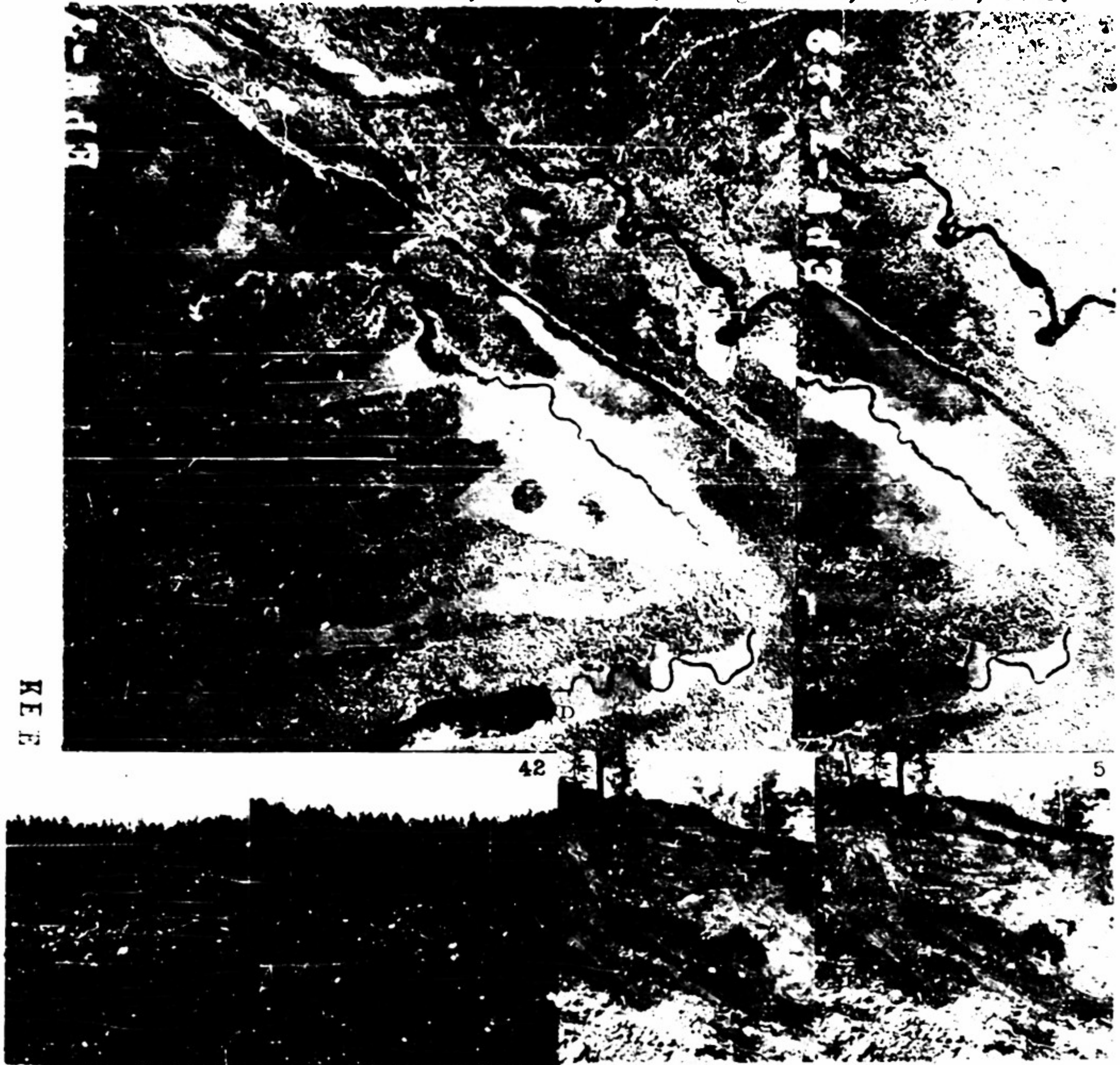


121

The upper stereo pair shows the rounded mound of a kame (K) with a gravel pit (G). Kames are glacial deposits of high content of gravel and like eskers (E) are often used as means of locating gravel. The difference in tone and texture between the 2 white booms of captured pulpwood in the upper pair and the booms of gray coarse textured logs in the lower pair is striking. The ground stereo 121 stacked pulpwood, with white bark of the birch and pale bark of aspen distinguishable. Whether the pale bark is or is not on wood in the boom, it still registers nearly white on the air photograph. At the left of 121 is shown Norway pines.

PLATE VIII

Stereo Infra-red Air Photographs, approx. 1/17,000. E.P.W. 7-23, 22, June 6, 1951. Showing a Road Built on an Esker in Maine. Ground Photographs of Glacial Till in Wisconsin; Taken by Ed. Steigerwaldt, Aug. 1[illegible], 1[illegible].



The upper stereo pair shows one of the numerous eskers in Maine utilized as a virtually ready-made road. (G) is a gravel pit. The beaver-dam ( ) with its dark-toned marshy area shows in greater contrast than it would on panchromatic photography. Stereo pairs 5 and 42 show glacial till in Wisconsin. The porous nature of the till can be inferred from the stand of hardwood forest on (5) and aspen-birch stand on (42).

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Tech. Rep. 6
Part. I

THE BROWNING OF VEGETATION

DETECTIBLE ON AIR PHOTOGRAPHS

ITS MILITARY SIGNIFICANCE AND DETECTION

Illustrated by

NY- (New York) Series of Plates

and

T- (Texan) Series of Plates

Air Photographs

and Information

by

Robert Heller

Forest Insect Laboratory,

U.S. Dept. Agriculture.

1950-51.

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Comparison of the effect of scale and of filters in detecting browning and in identifying textures. White pine plantation and low meadow, near Woodstock, N.Y., N.Y. State Game and Conservation Dept., Sept., 1950. Forest Insect Laboratory, Beltsville, Md.

Scale 1: 3600

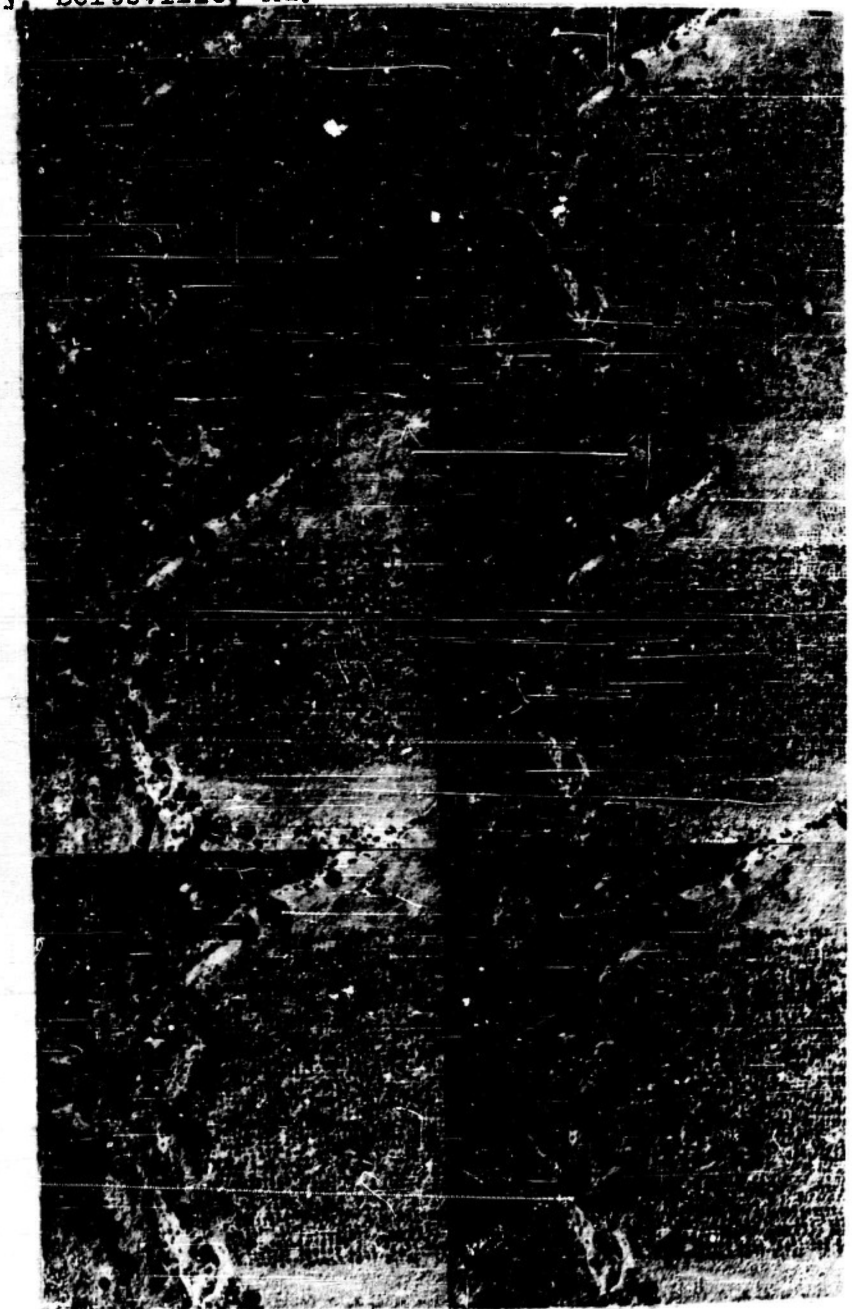
A filter

Scale 1: 3600

G filter

Scale 1: 2400

G filter



KEEP WIDE MARGIN

This and the following plate further illustrate the effect of scale and A and G filters on air photographs but in another locality distant from the (T) Texan series of plates. Here the object was the detection of browned and killed terminal shoots of white pines, photographed on color film, and panchromatic film. Unfortunately, the brown shoots registered very poorly on the panchromatic film to the extent that the photo interpreters recognize only 50 percent of them even on the largest scale (1/1200).

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Comparison of the effect of scale and of filters in detecting browning and in identifying textures. White pine plantation and low meadow near Woodstock, N.Y., N.Y. State Game and Conservation Dept. Plantation, Sept. 1950. Scale 1:1200. G (orange) filter. Showing same area as preceding plate. Forest Insect Laboratory, Beltsville, Md.

Scale 1: 1200 G filter

(Continued from preceding plate).

In notable contrast, color film taken at the same three scales enabled the interpreters to recognize 95% of brown shoot on the 1:1200 scale, about 80% on the 1:2400 scale, and approximately 75% on the 1: 3600 scale. A test of significance was made on the above study and no difference was noted among three observers using identical viewing equipment; however, there was a highly significant difference among the three scales. Just as the Texan series (Plate T-1 to T-4) clearly shows the great superiority of panchromatic over infrared film in recognizing browning of vegetation, the present series shows the superiority of color film over panchromatic film on 3 different scales for this same purpose. It seems obvious that the highest accuracy in the detection of browning for forestry or military purposes could be obtained by the use of the continuous-strip camera. It should be noted that the brown terminal shoots are roughly about 6" in diameter at the time when photographed. Note the textures shown by forest planting on the different scales: A = alders marsh; D = dead brown pines; P = living green pines.

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SECURITY INFORMATION

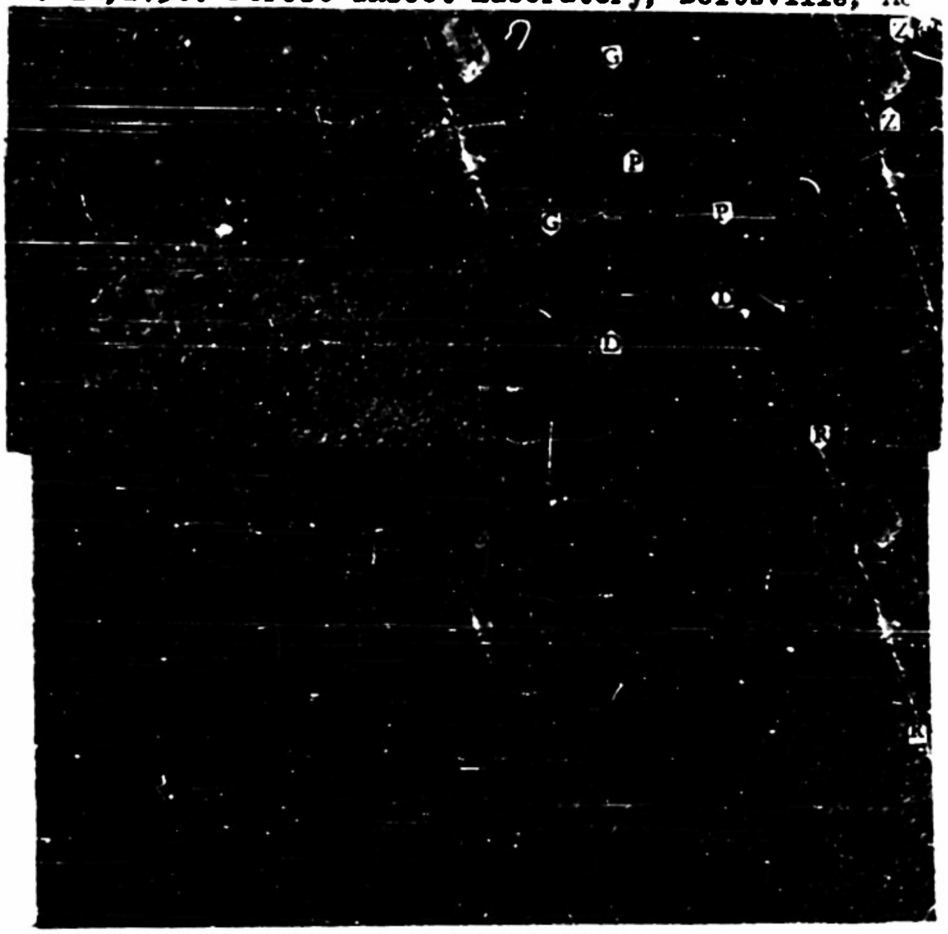
PLATE T-1

PART I Plate I of a series of 4 plates to show comparison of filters, films a scales for determining the best means of detecting browning of leaves. Stereo Panchromatic Air Photographs, Southern Pine-Hardwood forest, ne Beaumont, Texas; Nov. 11,1950. Forest Insect Laboratory, Beltsville, Md

KEEP WIDE MARGIN

Scale 1:15,840

A filter



Scale 1:15,840

G filter

This is the first of a series of four plates designed to show the effectiveness of two types of film (panchromatic and infrared), two kinds of filters (A-red and G-orange), and three scales of photography (1: 15,840; 1: 7920; and 1: 4800).

These pictures were made to detect the browning of pines caused by a bark beetle. Related beetles cause similar appearing damage in pine lands throughout the world.

Military operations damage the vegetation to a greater or lesser extent after varying periods of time. Such damage shows sooner or later as a change in color from green to brown in a variety of shades down to straw-color. Nearly all of these colors register on air photographs as much lighter toned than the neighboring green vegetation. This is shown in this series of four plates. Doubtless further study will enable the photo-interpreter to decide which filter and which film will be best to use for any particular shade of brown which indicates a corresponding military operation. For example, the locally common blackjack oak usually turns a rather reddish-brown, therefore, such killed oaks would evidently come up lighter in tone with an A filter than a G filter. (Continued on the following plate). D = dead brown pines; P = green pines; R = road on top of a oil pipe-line. Z is a marsh with a waterlily pond in its center. G = gum tree (Liquidambar styraciflua L.)

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SECURITY INFORMATION

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RT I

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SECURITY INFORMATION

PLATE T - 2

Plate II of a series of 4 plates to show comparison of filters, films & scales for determining the best means of detecting browning of leaves. Stereo Panchromatic Air Photographs, Southern Pine-Hardwood forest, near Beaumont, Texas; Nov. 11, 1950. Forest Insect Laboratory, Beltsville, Md.

KEEP WIDE MARGIN

Scale 1:7920

A filter

Scale 1:7920

G filter

(Continued from previous plate)

It might be thought that infrared film would be superior to panchromatic for registering the red-brown foliage. However, a comparison between the infrared photographs on plate T-4 with those on plates T-1, 2, and 3 show that exactly the opposite is true. It is readily seen that brown, dead pines (D) (encircled with white on plate T-4) are not distinguishable on the infrared pictures from the neighboring green pines (P). In contrast, on the panchromatic film, the dead pines can be distinguished on any scale with the A filter, and with more difficulty even with a G filter. IT CAN, THEREFORE, BE STATED THAT INFRARED IS AN UNSUITABLE TYPE OF FILM FOR USE IN DETECTING BROWNING OF FOLIAGE ANYWHERE IN THE WORLD. This sweeping statement is made on the basis of sound theoretical considerations, spectro photometric determinations on variously browned leaves, and most decisive of all on many series of air photographs taken by the Forest Insect Laboratory, Beltsville, Md. of many kinds of vegetation in the following widely separated forests: the spruce-fir forests in Maine and pines in New York, Maryland, and Texas. Orange colored goggles have been used by aerial observers of the Forest Insect Laboratory with striking success in locating distant dead brown trees, especially in hazy conditions.

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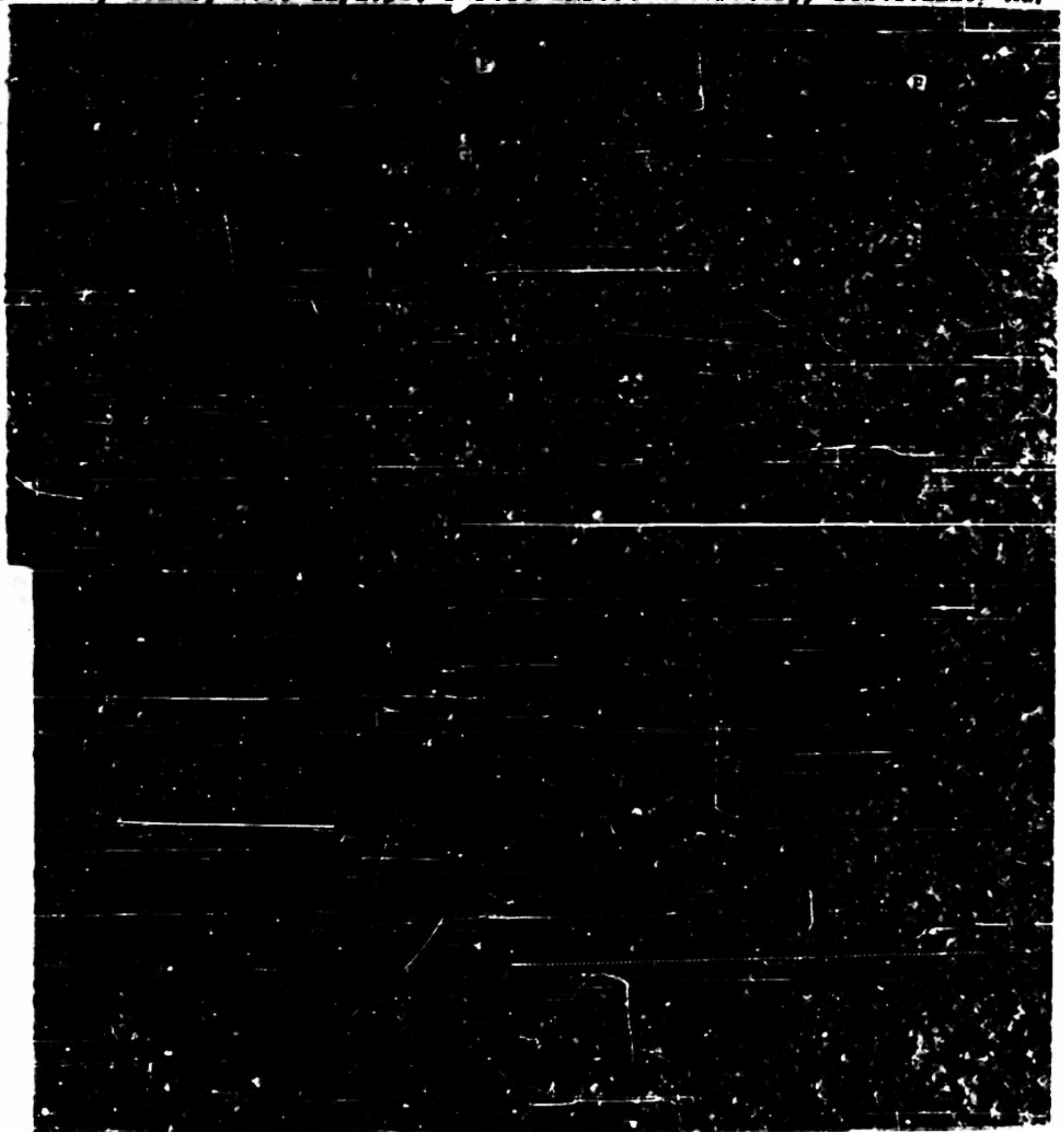
Plate III of a series of 4 plates to show comparison of filters, films and scales for determining the best means of detecting browning of leaves. Stereo Panchromatic Air Photographs, Southern Pine-Hardwood forest, near Beaumont, Texas; Nov. 11, 1950. Forest Insect Laboratory, Beltsville, Md.



The above photos were taken at a scale of 1:4800; the top pair was exposed through an A-25 (red) filter, the bottom pair through a G (orange) filter. Note the greater tonal contrast on the upper photo between the healthy green pines (P) and the dead brown pines (D). Note also the conspicuously light-tone registered by the prevailing reddish gum trees (G).

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PART I

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PLATE
T - 4

Plate IV of a series of 4 plates to show comparison of filters, films an scales for determining the best means of detecting browning of leaves. Stereo Infra-red Air Photographs, Southern Pine-Hardwood forest, near Beaumont, Texas; Nov. 11, 1950. Forest Insect Laboratory, Beltsville, Md.

Scale 1: 15,840

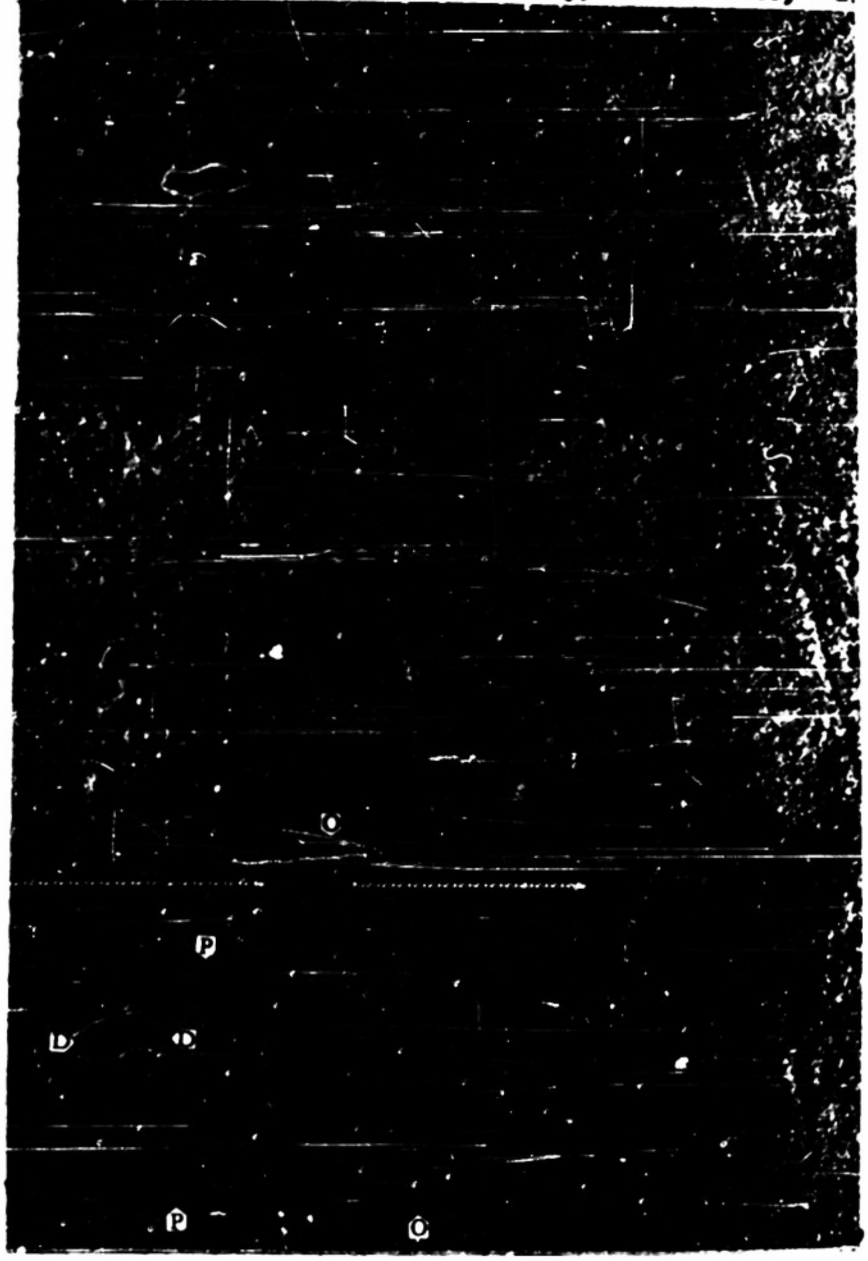
G filter

Scale 1: 7920

G filter

Scale 1: 7920

A filter



D = dead brown loblolly pines. O = oil pipe line
P = green loblolly pines.
(Pinus Taeda L.)

Although these infrared photographs do not show precisely the same locality illustrated on the first 3 plates, they were taken in the same forest about 20 miles distant. It should be noted that the trees in this forest average 80 to 00 feet in height and form a closed canopy. The underbrush, consisting largely of palmetto and smilax (i.e. cat brier, dog brier, devil's shoe string, etc. not blackberries) is a formidable obstacle to any sort of travel. ie combination of thick underbrush and the dense stand of tall trees constitute : effective barrier even to heavy tracked vehicles.

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Part I.

SOME TERRAIN CONDITIONS

DEDUCIBLE FROM SNOW

AS SHOWN ON

AIR AND GROUND PHOTOGRAPHS.

ILLUSTRATED

BY

SNOWFALL SERIES

OF PLATES.

Tech. Rep. 6
Part I.

SNOWFALL SERIES.

Plate I and Plate II of this Snowfall Series demonstrate that snowfall may often be a very considerable help and not always a hindrance to the photo-interpreter as is sometimes thought. The fundamental reason for this is the great increase between the contrast of the nearly pure white of the snow and the much darker tones of most other objects in the landscape.

Photograph 3909 on Plate I is a striking case of utilizing a snowfall in deducing terrain conditions. The white area in the right background is a patch of cord-grass completely covered by snow (s) while the gray patch in the left background is a patch of cat-tail (t). The boundary between these two types of vegetation is extremely sharp and very evident because of the high contrast. The other ground photographs of this spot on Plate I as well as the Air Photographs taken at seven different times of the year clearly demonstrate the advantage of a light fall of snow distinguishing these two types of vegetation.

The photo-interpreter will do well to note that both cord-grass and cat-tails commonly grow in distinct, often pure stands permanently wet terrain, i.e. marshes. But cat-tails nearly always mean deeper, softer mud than cord-grass, cause slower travel on foot, grow in fresh to brackish water. Stands of both plants occur in estuaries.

Tech. Rep. 6
Part I.

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Both plants have close relatives in Eurasia and each indicates nearly the same terrain conditions there as on the American continent. CORD-GRASS AND CAT-TAILS OCCUR IN THE COASTAL MARSHES OF THE BALTIC AND NORTH SEAS AND INDICATE LANDING AND TERRAIN CONDITIONS THERE.

By inference from the life-forms of cat-tails and cord-grass, it is clear that the stout stalks of the Eurasian cat-tails will mostly stand erect above any but a very heavy fall of snow (3 feet or more) or a heavy sleet; while the slender stalks of the Eurasian cord-grass will soon fall to the ground and be covered by even a light snowfall.

The 2 1/4" snow shown in 3909, fell slowly during the night of Nov. 29-30, 1952, with no perceptible wind. It therefore settled evenly, without drifting. From this it is logical to infer that the snow would melt always EVENLY on a uniform surface but UNEVENLY on a non-uniform surface. And this was the case (see Plate III).

HERE IS AN OPPORTUNITY FOR THE PHOTO-INTERPRETER TO LEARN AND TO PUT TO PRACTICAL USE THE ART OF DEDUCTION.

If the preceding is true, then a light, undrifted fall of snow should melt away evenly on a sandy beach, less evenly on a gravelly beach and show a still coarser texture on a beach strewn with large objects such as boulders, driftwood, cobbles, dead sea-weed, etc. The pattern of melting snow on gravel (Plate III) did not form on the adjacent sandy soil. The snow melted away evenly without showing any pattern.

Snow-falls Often Reveal Terrain Conditions as well as Conceal Them on Ground and Air Photography. Cord-grass most Clearly Distinguishable from Cat-tail Marsh After a Snowfall. The same locality evident but in much lower contrast on 2 ground photographs and 6 air photographs (on next plate) in different seasons.

Interpretation of vegetation in brackish marshes in many parts of the temperate and subarctic regions, as to landing conditions on coastal marshes is shown, by photograph 3909, to be greatly facilitated by a light fall of snow. The area marked (s) is permanently wet but distinctly better terrain for walking or vehicular traffic than the cat-tail marsh (t) nearly surrounding it.

(s) is a "salt meadow" where one kind of cord-grass (Spartina patens (Ait.) Muhl.) is 90% of the growth. It always indicates the presence of brackish water or sea water, an area slightly above the average high tide but subject to flooding during spring tides or high tides caused by on-shore winds. This grass can also be taken as indicating roughly how far upstream from the mouth or estuary of a river, barnacles will grow, i.e. in ascending a river, where this grass no longer grows in the marshes, the salinity of the water is too low for the growth of barnacles. 3909 (Nov.30,1952) and 3820 (Oct.19,1952) are panchromatic photographs taken through a G filter. 1819 (Nov.1,1949) panchromatic photograph without a filter, was taken after a heavy frost. The following plate shows the same area on air photographs at various times of the year and on three different scales.

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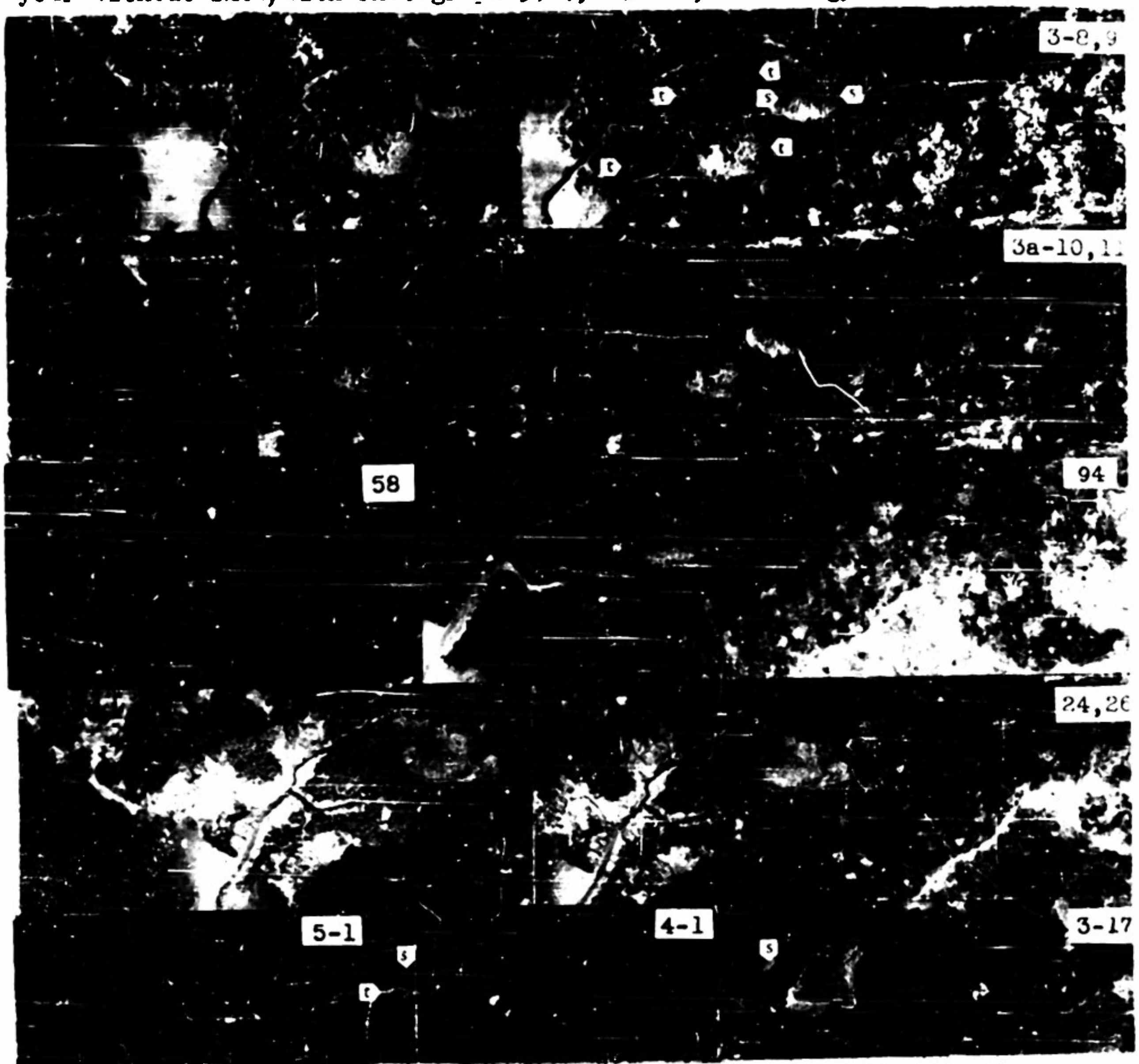
Snowfall Sometimes Facilitates Recognition of Terrain Conditions on Photographs. Compare These Air Photographs, Taken at Seven Different Times of the year Without Snow, With Photograph 3909, Plate I, Preceding, After a Snowfall.



All the above are panchromatic air photographs. 3-8,9 (Oct. 21, 1952) and 3a-10,11 (Nov. 12, 1952) were taken through a G filter; 94 (Dec.11,1949) and 58 (April 4,1950) form a quasi-stereo with one number taken at the beginning, the other at the end of winter; 24, 26 (May 9, 1950) shows no appreciable difference from the preceding 3 stereo pairs, all on approximately a scale of 1/2400; 3-17 (Aug. 10, 1948, 1/10,000) and 5-1, 4-1 (Sept. 15, 1949, 1/20,000) show the same stand in summer aspect and on smaller scales.

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ART I Interpreting the Pattern of Melting Snow as an Indicator of the Kind of Surface on Beaches. Oblique Stereo Photographs Indicating Presence of Gravel by the Pattern Assumed by the Melting Snow, which often Assumes Same Tussock-Forms as Reindeer Moss (G-1).

KEEP WIDE MARGIN

3900-R-

G-1

G-1 (taken by Gerard Gardner, Sept. 14, 1939 at 3 miles up stream from the mouth of Great Whale River 78° 28'W, 55° 17'N) shows the tussock-forms assumed by reindeer-moss in an open stand of white spruce (W). It is very noteworthy that snow, melting on a gravel surface, also assumes a very similar pattern, texture and tone. This similarity extends even to the type of drainage of the soil indicated - i.e. relatively dry terrain offering good travel conditions on foot or for vehicles, in both cases. 3900 and (39)04 (Nov. 30, 1952) were taken on a gravel surface on a bank fifty feet above the level of an arm of Chesapeake Bay, the body of water shown. The background of 3900 shows that a deciduous woods with branches covered with snow, sometimes make possible a sharper distinction between the individual trees in the background probably due to the reflected light of the snow lightening the shadows. See also Plate IV.

Persistence of Snow on the Branches of Trees Can Be Used in Detecting Troop Movements, in Facilitating Recognition of the Kind of Indicator Tree, the Trafficability of Fields and of Ditches.

3893 and 3908 (Nov. 30, 1952) both taken through a G filter in the Chesapeake Bay area, the first at 8:25 AM, the second at 10:10 show the difference in tone of branches of deciduous trees, with and without snow. A body of troops or vehicles moving through such a snow-covered forest, could sometimes knock off sufficient snow to show on air or ground photographs that there had been such a disturbance and the entire path seen. Another terrain condition often more clearly shown after a snowfall is the kind and amount of underbrush in the forest. Thus, evergreen shrubs like mountain laurel (Kalmia latifolia L.), at least, in horizontal and oblique views, retain relatively large clumps of snow in contrast to the leafless bushes. 13 taken late in Nov. 1952, Rimouski, Quebec, at the right center, the uniformly white patch is the completely snow-covered stubble of a grain field. The other fields in the left foreground not completely covered and showing considerable dark above the snow are relatively soft underfoot and are plowed latest of all. In planning travel routes across country at this time of year grain fields and never hayfields should be used. 29 (Rimouski, Dec. 4, 1952) shows the snow remaining much longer on the sandy bottom of the ditch than on dark, heat-absorbing peat.

PART I. PLATE - V

Snow Patterns Often Indicate the Presence and Kind of Surface of a Roa Recent Passage of a Vehicle; Vegetation Showing Above the Snow Indicates Terrain Conditions. Ski-tracks, Snow-shoe-tracks and Other Trai Visible on Panchromatic Photographs Taken in Sunlight.

KEEP WIDE MARGIN

On 3907 (Nov. 30, 1952, Chesapeake Bay) the tussock-pattern of the melting snow indicates: a) that the road is gravelled and not a smooth surfaced road; b) since the tussocks show, it is evident that no vehicle has been on this road since the snow fell. Vegetation showing above the snow can sometimes be used to help in estimating the snow. Frequently the position of a road buried under a deep snow is indicated by the hedge of trees and bushes. 13 and 14 (taken by G. Gardner, Laurentides, Quebec, Feb. 1952) show at the left by the regular straight lines and the marks of the " ski-poles " on one side only, that the three ski-ers were gliding down by gravity while the irregular lines and the set of holes on both sides of them snow that the solitary ski-er was toiling up slope. Descending snow-shoe tracks, at right of 14.

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Part I

TRAVEL CONDITIONS

in

FIR-PINE FORESTS

of

OREGON AND COLORADO.

Air Photographs

and Information

Illustrated

by

OC-Series of Plates

by

Robert Heller

Forest Insect Laboratory,

U.S. Dept. Agriculture.

1951-52.

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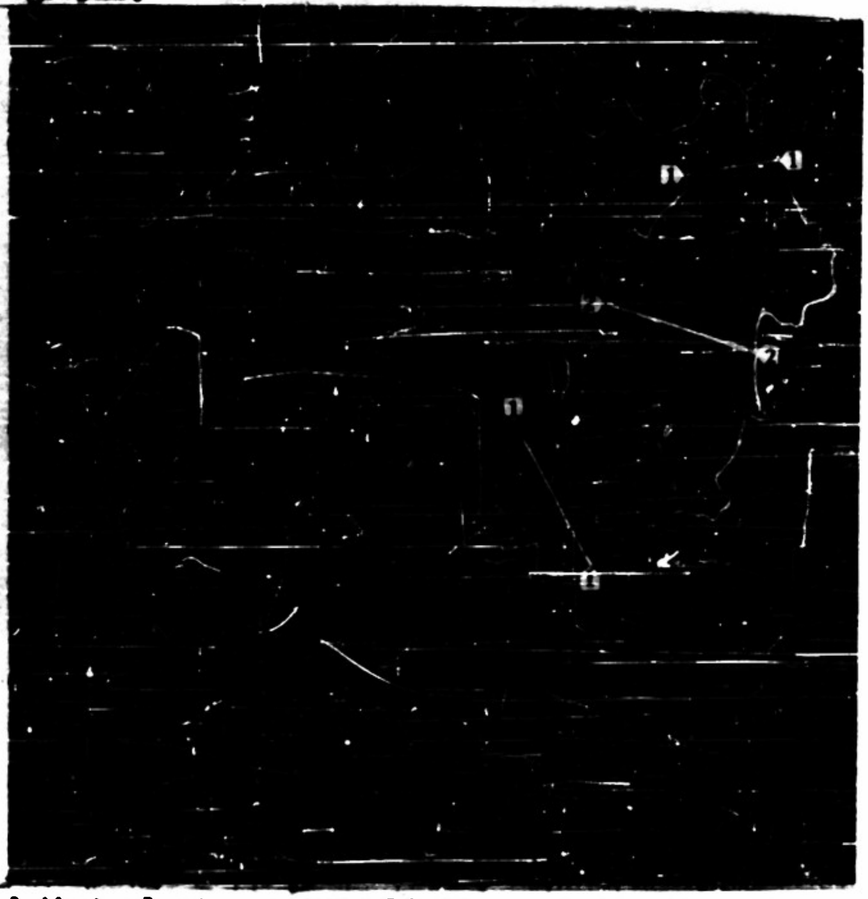
ART I

Recognition of Burnt-over Area in Douglas and White Fir Forest, near Bear Spring Ranger Station, Mt. Hood, National Forest, Oregon: July 31, 1951. Prod. and Mktg. Adm. CCJ. 171, 170 right. 1/20,000. Stereo Panchromatic Air Photographs.

KEEP WIDE MARGIN



It is often objected that plants are unreliable as indicators of terrain conditions because fire can destroy the vegetation at any time and that then, after such a fire, for many years, the area is devoid of any vegetation that gives any indication of the type of terrain. This is a very common error. As a matter of fact the vegetation that appears afte a fire, indicates the type of terrain nearly as much as did the previous vegetation destroyed by the fire.

This fact is plainly shown for the fir forest of Oregon on this and the following plate. About fifteen years after a "burn", the area appears on air photographs as outlined in white. Dense fir reproduction has invaded the area from either end and is readily distinguishable by its much finer texture. Since the trees are so much smaller a generalization that the texture on air photographs would be finer, applies here and proves to be the case. The best travel route is at (2) where hill top has denser vegetation. At (1) the sapplings are so thick as to constitute a real obstacle to foot travel.

In general, however, after a forest fire, the terrain becomes drier. In the case of severe burn, the layer of humus and some top soil will be destroyed so that the water holding capacity of the soil is greatly lowered. This drier terrain is indicated by the vegetation which may be more sparse, slower growing and of a different species, that are characteristic of drier terrain.

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SECURITY INFORMATION

PLAT
OC - 2

ART I

KEEP WIDE MARGIN

Recognition of Burnt-over Area in Douglas and White Fir Forest, near Bear Spring Ranger Station, Mt. Hood, National Forest, Oregon; July 31, 1951. Prod. and Mktg. Adm. CCJ. 170, 169 Right. 1/20,000. Stereo Panchromatic Air Photographs.

A forest fire about twenty five years ago caused this burnt-over area, that is, about ten years before the fire ravage shown on the preceding plate. Note the similarity of two burnt areas in spite of the difference in time. The best or least obstructed travel again is at (2) where the vegetation is thinnest and the terrain driest. This is a very much better route than at (1) where the growth of the saplings of fir is extremely dense and obstructive to any kind of travel.

Logging roads show good routes of travel and are easily recognized on air photographs as shown at the right of CCJ 169, above and especially on the following Plate OC-3.

Forest fires are very common in the coniferous forests of the Old World as well as in Alaska and Canada. It should be noted that in many such burnt-over areas, the vegetation that at first establishes itself, produces much more food for wildlife and an increase in the amount of game per unit area. This is of importance from the standpoint of survival or "living off the land" by small reconnaissance parties.

(Continued on the next plate OC-3).

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PART I Alder Marsh and Lower Limit of Tree Growth at Grazing Land, in a "Ponderosa" Pine-Douglas Fir Forest, near Bear Spring Ranger Station, Mt. Hood, National Forest, Oregon; July 31, 1951. Prod. and Mktg. Adm. CCJ. 3 H 70, 71 (right). 1/20,000. Stereo Panchromatic Air Photographs.

(continued from the preceding Plate OC-2)

A travel route based on the burnt-area recognized on air photographs can be plotted to take advantage of this fact in many similar areas in Alaska, Canada and USSR, so that the route skirts the denser brush but still does not go through it while taking advantage of the more abundant game living there. The boundary of the uncut, unburnt fir forest in the upper left corner is evident. The abundant logging trails (l) everywhere are an indication of the small rainfall, the relative dryness of the terrain. The lower area has a thin covering of dead straw colored grass (d) where travel conditions are very good but concealment and cover totally lacking. The edge of the forest and the gully show a much darker tone, registered by dark green grass (g) an indication of moister terrain. A small marsh (A) of alder bushes, of characteristically even height and dense growth, registers necessarily as very even tone of gray. As everywhere else alders indicate permanently wet terrain and difficult travel conditions.

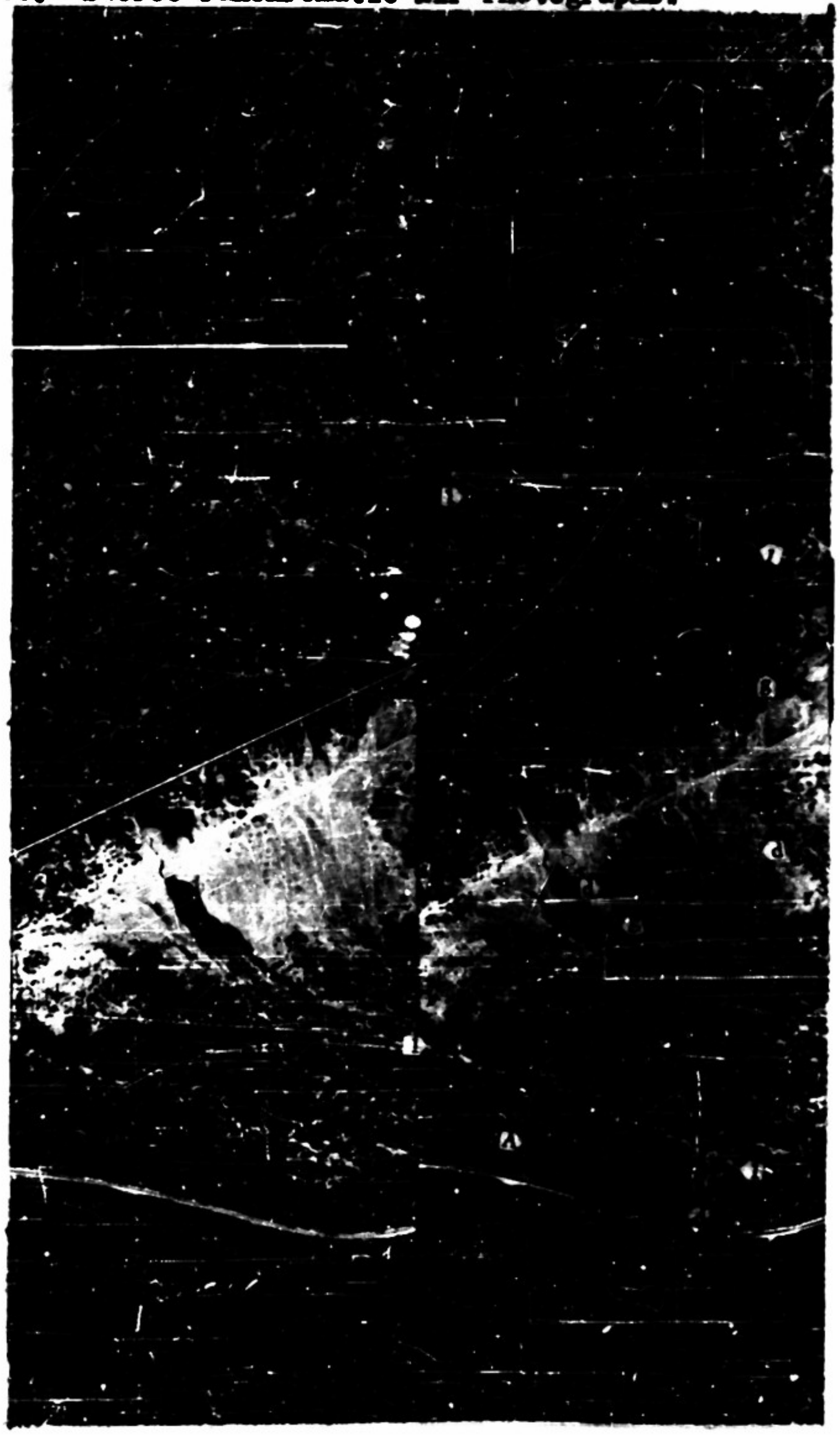

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PLATE OC - 4

ART I Difference in Travel Conditions on the Moister Northwest-facing Slopes and the Drier Southeast-facing Slopes in the Douglas Fir and "Ponderosa" Pine Forest near Bear Spring Ranger Station, Mt. Hood, National Forest, Oregon; July 31, 1951. Prod. and Mktg. Adm. CCJ. 3 H 56, 57 (right). 1/20,000. Stereo Panchromatic Air Photographs.

KEEP WIDE MARGIN

The effect of aspect (here used to mean the direction in which a slope is facing) on the vegetation is illustrated by this and plate OC-5. These differences are greatest when the slopes are more nearly facing in north and south directions, and least in east- or west-facing slopes. (Naturally the direction of prevailing moisture bearing winds will modify or even obliterate this effect.) For example, on the drier southeast facing slopes shown above, foot travel is relatively unobstructed since there is a minimum of tree reproduction and bushy herbaceous growth. Exactly the opposite is true on the northwest-facing slope. Instead of finding fairly open stands of "ponderosa" pine (P), the vegetation has become more dense with considerable douglas fir (D) reproduction mixed with both pine and mature fir. If the ground is not covered by dense stands of young sapplings, it is occupied by a thicket of bushes of "ground chinquapin" mixed with manzanita, which grows under the more mature stands of trees.

Obviously, the least obstructed route of travel would be along the south -- facing slopes shown by the white line numbered (2). In contrast, a reconnaissance party proposing to travel unobserved would choose the other route (1) which would take longer, be more difficult, but offers more cover. These photographs of forests in Oregon and Colorado (Plate OC-5) demonstrate that vegetation growing in similar though widely separated hilly or mountainous relatively dry areas, appears similar. Examination of photographs of other such areas shows that this is a valid generalization for vegetation anywhere in the world.

D = Douglas Fir; P = "ponderosa" pine.

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Difference in [illegible] on moister north-facing and drier [illegible] forest type, Rocky Mountain National [illegible] Sept. 1952. Fores[illegible] Insect Lab., Beltsville, Md [illegible] U.S.D.A. [illegible] Stereo Air Photograph

KEEP WIDE MARGIN

Taken with orange (G) filter, the upper on scale of 1/7920, the lower on scale of 1/5840. In the drier parts of the world outside the tropics the slopes which face the sun have less vegetation than the opposite slope and therefore less concealment, but less obstruction from vegetation. Travel routes are therefore planned to conform to this type of vegetation. The G filter has greatly facilitated the recognition of the dead pines (upper right corner).

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DEFINITION OR SHORT GLOSSARY

Because so many interpreters who will use this report, will not have had the opportunity of studying botany or geology or climatology, etc., it was felt that a list of some of the terms used in this Report might be of occasional use to at least some of the interpreters, if they were defined here. Unavoidably, this list is more or less arbitrary as are also some of the definitions. However, some of the terms have been included here because class work with our previous reports showed this to be necessary.

ARCTIC: See Map No. 1, Part III at the end of the Introduction. In the botanist's concept, this is the circumpolar region extending as far north as there is land not permanently covered by snow or ice and as far south as the tree line (see below) which roughly corresponds to the 50° F. or 10° C. isotherm for July. See also "Arctic Definitions" issued by the Environmental Protection Section, Office of the Quartermaster General for the Research and Development Board, Logistics Division Study. April 5, 1948. See also Technical Report No. 5 Preface viii.

BOG: "Wet and spongy ground, usually covered with coarse grass and often containing peat, etc., and too soft to bear the weight of any heavy body on its surface." "An area overgrown with sphagnum or bog moss."

BOG (cont'd): Ecological Society of America, 1933. List P-1.

BOREAL FOREST: See Map No.1, Part III. Roughly, all the forest in the sub-arctic region may be called the boreal or circumboreal forest. Sometimes also defined as having "the governing temperature for the southern limit, for the six hottest weeks of the year a mean temperature of 64°F." J.R. Carpenter: An Ecological Glossary.

CIRCUMBOREAL FOREST: See Boreal Forest preceding.

CONIFER OR CONIFEROUS TREE OR SHRUB: A tree or shrub whose fruit is a cone as understood by a botanist. In the sub-arctic area these are: spruces, firs, pines, junipers, white cedars, hemlocks, yews and larches. All of these have needle- or awl-shaped evergreen leaves except the larches whose leaves die and fall off at the end of the summer.

DECIDUOUS: As applied to leaves, means those that die and fall off the tree at the end of the summer or some time in autumn or winter. Not evergreen.

EVERGREEN: As applied to leaves, means the leaves stay on the twigs in a living, green condition at least one year, that is from spring to at least the next spring. Certain species of spruce and fir retain their leaves in a living condition for as long as 2 to 7 years. The older the leaves, the darker they become, EVERGREEN (cont'd): mostly by accumulation of dust, soot from forest fires, etc. on the resinous or waxen outer coat of the leaf. All evergreen trees in the arctic and subarctic are conifers. A considerable number of shrubs, mostly heaths, are evergreen, such as the arctic rhododendron, Labrador tea (Ledum), etc. These are low bushes commonly 1 to 2 feet high.

FIR: In England commonly the Scotch fir (Pinus sylvestris L.). This tree is called Scotch PINE in the United States where fir means a species of Abies, such as, balsam fir, probably the most common Christmas tree in the eastern states. Abies has cones erect on the branches and needles singly disposed on the branches, but Pinus has drooping cones and leaves, 2 or more in a bundle, in the boreal forest.

GRASSLAND: As defined by Tansley and Chipp(1926) "Trees and shrubs usually absent; herbaceous covering general; grasses predominate." See Herbert C. Hanson: Ecology of the Grassland I, Botanical Review 4: 51-82. 1938 and II. 16: 283-360. 1950.

HARDWOODS: In the lumber industry, all deciduous trees (aspen, birch, sugar-maple, etc.) in contrast to coniferous trees (spruce, fir, pine, etc.)

HEATH OR HEATHER: A community of plants, mostly shrubs with a considerable percentage of heaths (Ericaceae) such

HEATH OR HEATHER (cont'd): as blueberries, cranberries, rhododendron, arctic rhododendron, Labrador tea (Ledum), etc. usually on relatively coarse-grained, sandy soil with dark humus layers, generally with a layer of peat.

HUMMOCK (HAMMOCK is a variant?): A large mound in a swamp or bog; a large tussock.

INDICATOR OR INDEX PLANT: Any plant considered as an indicator of the environment, i.e. the soil and subsoil, the local climate, competition with other plants, etc. See our Technical Report No.1, Part IV, page 1.

MARSH: An essentially treeless plant society growing where the water table is at or slightly above the surface of the land. Shrubs may or may not be present; sedges are almost invariably present. Familiar examples of marshes are: cattail marsh, salt marsh, cranberry bog, peat or sphagnum bog, etc.

MUSKEG: "An Algonquian word meaning a wet and/or muddy place." Dr. James Geary. Dachnowski-Stokes: "A plant community associated with peat." Haviland: "Moss bogs of the Canadian forest." (1926)

("NIGGERHEADS"): See Tussocks.

(PHOTO-DETERMINATION): See Photo-recognition.

(PHOTO-IDENTIFICATION): See Photo-recognition.

PHOTO-INTERPRETATION: "Identification or recognition of objects on photography is best called "photo-identification" or "photo-recognition." "Photo-reading" sometimes used in this sense is much more apt to lead to confusion. "Reading" connotes the apprehension of ideas expressed in some arbitrary man-made code or alphabet. Recognition or identification of physical objects connotes direct apprehension of the object without the intermediary of arbitrary symbols, alphabets or languages. In the interests of international understanding I recommend that the term "photo-reading" be discarded in favor of "Photo-identification" or "Photo-recognition." Hugh T. O'Neill, at the Seventh Congress of the International Society of Photogrammetry, Sept. 1952.

(PHOTO-READING): See Photo-recognition.

PHOTO-RECOGNITION: The identification or recognition of an object on a photograph considered without regard to what it indicates as to its environment.

ROCK: Throughout this report, rock is used in the sense commonly understood by everyone except geologists, viz, what geologists call consolidated rock. The term rock, in its popular acceptation, embraces only the solid parts of the globe; but in geological language, it includes also the loose materials, the soils, ROCK (continued): clays, and gravels,-that cover the solid parts.

RUNNEL: A small run; a streamlet; a rivulet.

SEEPAGE: (Or seep) a small spring; a place out of which oozes water. In England, a flush.

SHRUB: A BUSH. A plant with a woody stem, generally with a cluster of such stems, lower than a tree, sometimes defined as not more than twice the height of a man.

SOFTWOODS: In the lumber industry, all cone-bearing (coniferous) trees, i.e. spruce, fir, pine, etc., in distinction to deciduous trees (aspen, birch, sugar-maple, etc.) regardless of whether their wood is hard (birch) or soft (aspen).

SUBARCTIC: While there is a fair amount of consensus of opinion as to the approximate limits of the natural Arctic region, there is much less agreement as to how to delimit the subarctic region. Until further studies are available none of the available maps have been adopted. In general, the subarctic region may be said to correspond to the circumpolar or boreal forest, that is, a zone extending from the southern boundary of the Arctic zone to the southern boundary

SUBARCTIC (continued): of the spruce forest, at least in northeastern U.S. With further study it is hoped that a more practical southern boundary for the subarctic zone can be outlined from the standpoint of the photo-interpreter.

SUPERPOSABLE MAPS: Maps of the same style of projection and drawn to the same scale so that when placed (superposed) one on top of the other, they will coincide at all points. When a line is drawn on one of these maps to represent a facttor of the environment (e.g. an isotherm) and on a second of these maps there is drawn a line representing another factor of the environment (e.g. the tree line), the coincidence or non-coincidence of the two lines can be seen and therefore the correlation or non-correlation of the two factors when these maps are superposed over a source of bright light, i.e. a light table. In the above example the 10° C or 50° F isotherm for July corresponds to the tree line indicating that trees require an average summer temperature of 50° F or higher.

SWAMP: A society of trees growing where the water table is at or slightly higher than the surface of the land.

SWAMP (continued): Shrubs may or may not be present but by far the dominant vegetation is trees. Familiar examples are: Tamarack or larch bog, black spruce bog or swamp, white cedar swamp, etc. In everyday English we speak of a cypress swamp (not marsh) and a cat-tail marsh (not swamp).

TAIGA: A Russian term adopted into the English language commonly and loosely used to mean the vegetation and even the area between the steppes and tundra of Russia, occasionally to mean the cooler circumboreal forest or the spruce forest in Canada and Alaska.

TALUS: "The sloping mass of fallen fragments collected at the base of a cliff"; a scree.

TERRAIN: "A region considered in relation to its fitness for some purpose; an extent of ground or territory".

TREE: A plant with a woody stem persisting in a living condition above the ground, becoming more than twice the height of a man and commonly with only one main or very few stems or trunks. Taller than a shrub or bush and with fewer trunks.

TREE LINE: See Map No. 1, Part III where the tree line is shown as the boundary between the Arctic and the Subarctic Regions. As marked on the map, this is the July isotherm of 10° C or 50° F, that is, this line connects places where this is the average temperature for the warmest month of the year. In general there are no trees growing naturally in this region except in a few very sheltered small localities, such as south-facing coves or valleys. e.g. A. Dutilly found a colony of willows 6 to 8 feet tall on Banks Island more than 300 miles north of the Arctic Circle. Cottonwood trees are reported growing north of the Brooks Range in Alaska. But in a general way and for purposes of photo-interpretation the region north of this isotherm can be regarded as treeless.

TUNDRA: A Russian word adopted into English usage. The treeless region of the arctic with low vegetation overlying permanently frozen ground that thaws shallowly in the summer to a depth of a few inches to a foot or two.

TUSSOCKS: The small mounds in marshes, tundras or less commonly in swamps. Tufts of sedges or grasses or rushes; locally "Niggerheads".

WATER TABLE; "The level of saturation of soil by ground water". Or simply, water-level.

Tech. Rep. 6
Part I

Aids in Reading Russian Maps and Russian Titles of Books

Transliterating the Russian into the Roman Alphabet.

Russian (Cyrillic) Letters	Trans-liter-ation	Approximate Pronunciation	Russian	Trans-liter-ation	Approximate Pronunciation
А а	A a	harm	Р р	R r	rat
Б б	B b	bed	С с	S s	sat
В в	V v	vat	Т т	T t	tire
Г г	G g	garb	У у	U u	dune
Д д	D d	day	Ф ф	F f	fat
Е е	E e, ie	yell	Х х	Kh kh	German ich
Ж ж	Zh zh	azure, French "j"	Ц ц	Ts ts	mats
З з	Z z	zeal	Ч ч	Ch ch	cheap
И и	I i	machine	Ш ш	Sh sh	ship
Й й	I i	toil	Щ щ	Shch shch	fresh cheese
К к	K k	king	Ы ы	Y y	silly
Л л	L l	long	ь	soft sound	
М м	M m	man	Э э	E e	ebb
Н н	N n	nut	Ю ю	Yu yu	yule
О о	O o	bore	Я я	Ya ya	yard
П п	P p	palm			

Tech. Rep. 6
Part I

Aids in Reading Russian Maps

PRACTICE SHEET

The Advantage of Transliterating Russian into Our Alphabet can be seen from the following List of Russian Words of Foreign Origin. The student can write under the columns his transliterations. On the next page he will find the corresponding correct transliterations and translations.

RUSSIAN WORD	Transli-teration	Transla-tion	RUSSIAN WORD	Transli-teration	Transla-tion
АДРЕС			МЕТАЛЛ		
АМЕРИКА			МАТЕРИАЛ		
АНОД			МЕДИЦИНА		
АППАРАТ			МЕТР		
АСБЕСТ			МИНУТА		
АТОМ			МОТОР		
ВРОНЗА			НЕРЬ		
ДЕФЕКТ			ПАРК		
ДОКТОР			ФИЗИКА		
ДОЛЛАР			РАДИО		
ЭФФЕКТ			ШКАЛА		
КАПИТАН			СУП		
КАНАЛ			ТЕАТР		
КОФЕ			ЦЕМЕНТ		
КОЛЛЕДЖ			ЦЕНТР		
КРИСТАЛЛ			ВАКЦИНА		
КЧБ			ВЕТЕРАН		
КУРС			ЖИРАФ		
МАЩИНА			ЖОРЖ		

PRACTICE SHEET

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RUSSIAN WORD	Transliteration	Translation	RUSSIAN WORD	Transliteration	Translation
АДРЕС	adri͡es	address	МЕТАЛЛ	mi͡etall	metal
АМЕРИКА	ami͡erika	America	МАТЕРИАЛ	mati͡erial	material
АНОД	anod	anode	МЕДИЦИНА	mi͡editsina	medicine
АППАРАТ	apparat	apparatus	МЕТР	mi͡etr	meter
АСБЕСТ	asbi͡est	asbestos	МИНУТА	minuta	minute
АТОМ	atom	atom	МОТОР	motor	motor
БРОНЗА	bronza	bronze	НЕРЬ	ni͡erv	nerve
ДЕФЕКТ	di͡efi͡ect	defect	ПАРК	park	park
ДОКТОР	doktor	doctor	ФИЗИКА	fizika	physics
ДОЛЛАР	dollar	dollar	РАДИО	radio	radio
ЭФФЕКТ	effi͡ect	effect	ШКАЛА	shkala	scale
КАПИТАН	kapitan	captain	СУП	sup	soup
КАНАЛ	kanal	canal	ТЕАТР	ti͡eatr	theatre
КОФЕ	kofi͡e	coffee	ЦЕМЕНТ	tsi͡emi͡ent	cement
КОЛЛЕДЖ	kolli͡eg	college	ЦЕНТР	tsi͡entr	center
КРИСТАЛЛ	kristall	crystal	ВАКЦИНА	vaktsina	vaccine
КЧБ	kub	cube	ВЕТЕРАН	vi͡eti͡eran	veteran
КУРС	kurs	course	ЖИРАФ	zhiraf	giraffe
МАЩИНА	mashina	machine	ЖОРЖ	zhorzh	George

PRACTICE QUESTIONS BASED ON SERIES OF PLATES M-1 TO M-30 OF TECHNICAL REPORT 6, PART III
(See following sheets for answers)

BY RICHARD M. SHAMP

Plate M - 1

1. Would it be practical to follow the stream at point QQ on the right hand side of aerial shots?

2. In climbing the slope on the left side of photo, would it be best to follow the ravines or the sections between the ravines?

3. Would the area between S-S in the middle of the picture be a good route of travel?

Plate M - 2

4. Would the talus slopes at (t) impede travel?

5. Does the willow and birch with the scattered black spruce indicate a good route of travel? Would it be best to push through it or attempt to circumvent the area?

Plate M - 3

6. Which would be the best route of travel in the left photo of the stereo pair: (1) the gravel bed of the stream valley, (2) the willow thicket along the bank, or (3) the steep slope covered with reindeer moss? State advantages and disadvantages of each.

7. What type of soil drainage is indicated by the tall growth of white spruce and aspens?

Plate M - 4

8. What is the procedure you should follow in crossing rapid glacier streams?

9. Does the light tone in the upper right hand corner of the photo indicate snow?

Plate M - 5

10. What are the scattered dark patches in the lower right hand corner of photo (56-2)?

11. Would it be less treacherous to follow one of the snow-filled passes or attempt to follow the well defined ridge lines in photo (56-2)?

12. What is the best procedure in (a) climbing a talus slope, (b) descending a talus slope?

13. What indications are there that a talus slope is becoming stabilized?

Plate M - 6

14. What difficulties are encountered when traveling above the tree-line?

15. What advantages are there in the absence of vegetation?

Plate M - 7

16. What causes the deltas to be fan-shaped in the aerial photographs?

17. What would cause different vegetation to grow on the deltas than in the surrounding areas?

Plate M - 8

18. The light streaks up the far slope of the lake are indicative of what?

Plate M - 9

19. Why should erosion be so predominant when it is absent in adjacent areas in the lower left hand corner of the aerial shots at X?

20. What conditions are you likely to find in the dark areas of the lower right hand corner of the aerial shots?

Plate M - 10

21. What causes the dark streak at e-e?

22. Would the ripple-like marks at a-a offer any hazards?

23. What is the best time of year to traverse a glacier?

Plate M - 11

24. Is the glacier shown in these photos advancing or receding?

25. What causes the light color of the rocks in photo 10-2?

Plate M - 12

26. What is the source of the stream in photo (75-6)?

Plate M - 13

27. The willow growth on the stream bank in photo (67-3) would indicate what time of the year?

28. Would igneous rocks be likely to erode in the manner of the waterfall depression on photo (75-9)?

Plate M-14

29. Would the snow bridge be safe to cross in photo 75-0?

30. How are such bridges formed?

Plate M - 15

31. Why does the stream in the aerial shots follow such a straight course?

32. What are you able to surmise about the consistency of the soil in the middle of the aerial shots and the lower half of the pictures?

33. How is the soil consistency indicated by the course of the stream?

34. How is the soil consistency indicated by the tone of the vegetation?

35. What type of soil is indicated by the growth in photo (10-9)?

Plate M - 16

36. What are the dangers of crossing glacier streams in the manner of photo 8-4? By method in photo 75-7?

Plate M - 17

37. What causes the variation of vegetation in photo 7-1; the grasses in the front, then the aspens and willows, and then the white spruce?

Plate M - 18

38. Why is the water in the arrow-shaped pond in the center of the aerial photos and that in the stream different in tone?

39. Is the light tone at (z) on the aerial photos due to snow?

40. Why is there an absence of vegetation at (z-z) in the aerial photographs?

Plate M - 19

41. Why do some of the trees at (B) in the photo (84-8) appear to be dead?

42. What is the cause of the change of vegetation at (E-E) in photo (84-9)?

43. Would this be a good area to ascend or descend the slope?

44. What causes the lack of vegetation and the light tone at the lower left corner of photo 84-9?

Plate M - 21

45. What causes the dead trees on the left side of photo 115-1 and the apparent absence of spruce trees in the middle of the photo?

46. Why hasn't the willow growth invaded the sand bars along the river near the center of the aerial photos?

Plate M - 22

47. What causes the light streaks at (13-3)?

48. What type of vegetation is located in the area of (4-5) and (4-10)?

Plate M - 23

49. What is the advantage of photo (186-3) over photo (4-2)?

Plate M - 24

50. Why is the route at (x) in photo (4-1) apparently clear of scrub brush?

51. What has caused the trees to die in photos (13-3) and (13-4)?

52. What would be the difference in soil conditions in photos (13-4) and (4-1)?

53. Why is there no scrub birch in the foreground of photo (4-10)?

Plate M - 25

54. Has the valley illustrated in photo (B-2) been glaciated?

55. What type soil would you be likely to find at the crow-foot delta where the stream enters the lake on the aerial shots?

56. What causes the light tone between (o-o) of the aerial shots?

57. What soil conditions have caused the extremely large spruce growth in photo (B-1)?

Plate M - 26

58. Explain the formation of the moraine as shown in photo (9-1).

Plate M - 27

59. Why would it be better to walk on the moraine than on the surrounding glaciers?

Plate M - 28

60. What type of game would use a trail as shown in (Z-Z) of the aerial photographs?

61. What are the advantages of following game trails?

Plate M - 30

62 Where will you find large rocks as shown in photo (8-3)?

63 What dangers are there in following snow-filled valleys as shown in photo (9-3)?

Additional Questions

by

Hugh O'Neill

64 Would a lighter print of the negative of M-10 show more detail of the steep rock walls of the deep depression in the middle of the right member of the stereo pair?

65 Would the details of the surface of the glacier, such as a crevasse, show more plainly on a lighter print?

66 The leaves of scrub-birch (E on Pl. M-13) turn red after the first killing frost in September, while the leaves of the willow bushes (indicating wetter terrain) turn yellow. For difrentiating these types of vegetation and the different terrains they indicate, would color or infra-red or panchromatic film be best?

ANSWERS TO QUESTIONS ON PART III
OF TECHNICAL REPORT #6

1. No; it flows through a deep canyon at this point.

2. The sections between the ravines. The ravines are filled with tangled thickets of willows and alders.

3. This area consists of willow thickets interspersed with scrub birch. Therefore, it is a very poor route of travel unless a game trail can be found passing through it.

4. Steep talus slopes are a hindrance to climbing slopes, but if the rocks are not large, they do not hinder a descent.

5. The black spruce indicates a fair route of travel, but seldom is it found with such thick growths of willow and birch. If possible, it would be best to circumvent this area.

6. (1) If the stream is not in flood stage, the gravel bed is an excellent route of travel. However, the braided streams require frequent wading.

(2) Willow thickets of this height usually are crossed by game trails; however, if they aren't, they are almost impossible to traverse.

(3) Although there is no vegetation on this slope, the rock outcrops make the footing difficult. Also, the reindeer moss is very slippery when wet.

7. Rich, well-drained soil.

8. All possible precautions should be followed. The use of ropes, downed trees and any other means available should be utilized.

9. No. This is reindeer moss.

10. Scattered plots of grasses, showing that the talus slope is becoming stabilized.

11. If the snow is crusted and does not break through, it is by far the easiest route of travel. However, if it is soft, it is best to follow the ridge lines despite the steeper climb.

12. Ascend the slope at a very slight angle to prevent slides. If the rocks are not too large, it is possible to descend the slopes almost vertically by keeping ahead of the slide.

13. The small patches of grass.

14. Usually steeper slopes and talus slides are encountered; also, snow fields are at times difficult to traverse. It is difficult to find firewood above the tree line.

15. The absence of trees and undergrowth makes walking easier. There are usually fewer insects above tree line.

16. The sediment-laden streams slow down as they enter the lake and drop their load in the patterns as indicated by the fan shaped deltas.

17. The difference in drainage and composition of the soil of the two areas causes different types of vegetation.

18. Rock and soil slides have destroyed the spruce growth and willow and alder thickets now grow there. This type of growth is also indicative of near surface drainage or seepages.

19. Fire has destroyed the forest in this area, thus exposing the soil to rapid erosion.

20. Upland swamps. Black spruce, tamarack and muskeg.

21. This is a medial moraine.

22. They are crevasses and should be avoided.

23. In the late summer or fall when the non-compacted snow has melted off the glacier and the crevasses are exposed.

24. It is receding. The rocks in the foreground were deposited by the glacier when it previously covered this area.

25. The rocks are covered with lichens and reindeer moss.

26. It is flowing from beneath the moraine deposit in the foreground of the picture.

27. The trees are still in bud, indicating that it is the spring of the year.

28. No. The rocks have been dissolved, thus causing the depression. This would not occur if these rocks were of igneous character.

29. Yes. Care should be taken, but usually they easily support the weight of a man.

30. The slides which occur, carry rocks and trees with them and completely cover the streams.

31. It is following a fault pattern.

32. The soil in the middle of the picture is alluvial and less compact (note the braiding effect), while in the lower part of the picture, the stream bed is cut into solid rock (no meandering or braiding).

33. When the soil is unconsolidated or easily transported, the stream can meander and braid with ease, while it is confined to its course when it cuts through solid rock.

34. Willows and alders will grow readily in moist alluvial soil while the solid rock supports only reindeer moss as indicated by the light tone.

35. This is a willow thicket growing in the braided section of the valley. This is moist, alluvial soil.

36. (a) A tree in this position is usually rotten and may break easily; also it is very easy to trip and fall on one of the branches.

(b) This type of stream is very rapid and its force may easily upset you. The rocks are very slippery and often will throw you off balance.

37. The support of different types of vegetation by different types of soil is very apparent here. Drainage also controls the vegetation types somewhat.

38. The water in the stream is milky due to the glacial flour in the water. The water in the pond is perfectly clear.

39. No. It is a light-colored rock out-crop.

40. There is little soil on this rock out-crop; therefore, it does not support vegetation.

41. The area has been flooded causing the trees to die.

42. This is a slide area and an area of close surface drainage, thus supporting the willow and birch growth.

43. No. It would be difficult due to the tangled growth. It would be much better to ascend in the region of the spruce growth.

44. This is the rock outcrop described in question #40. There is no soil to support vegetation.

45. This area has recently been burned over. The dead trees in the left of this photo and the absence of spruce trees are a result of this.

46. The aerial shots were taken during low water. The sand bars exposed are covered by the river most of the year.

47. Alluvial deposits along small streams; gravel and sand.

48. Caribou moss and lichens.

49. It is easier to see detail in the distance, due to the absence of haze. Infra-red gives different tones to vegetation making it easier to identify.

50. This is a game trail.

51. The spruce trees have been killed by the formation of swamps in the area; the growth of willow and tamarack increases in this type of terrain.

52. The terrain in photo (4-1) is gravelly and well drained, while in photo (13-4) it is swampy, muskeg terrain.

53. This area is above the tree and bush line. The only types of vegetation are lichens and mosses.

54. No. Glaciated valleys are U-shaped. This valley is V-shaped.

55. Mud and fine silt. Difficult to traverse.

56. This is the former course of the stream. It was changed as a result of beaver damming.

57. Rich soil with good drainage.

58. This moraine is formed between the two glaciers as shown in the aerial photos. It is composed of rocks ground off from either side of the mountain it surrounds.

59. There are numerous snow-covered crevasses at the tongues of these glaciers, thereby making it more desirable to follow the moraine.

60. Moose, caribou, bears, wolves and smaller animals.

61. Although they wind at times more than necessary, these trails always follow the easiest natural routes. It is not necessary to push through bush or windfalls.

62. At the base of steep slopes.

63. The danger of falling through into the rushing stream flowing underneath the snow.

64. Yes.

65. No. Such details on the light snow-ice background would show up better on a darker print.

66. Obviously color would be very much better than either of the other kinds of photography.

PRACTICE QUESTIONS BASED ON SERIES OF PLATES I-XXVI
OF TECHNICAL REPORT 6, PART III
by
ARTHEME DUTILLY AND VINCENT WALDRON

(See following sheets for answers.)

Plate I:

1. Is the system of rivers on the small-scale photograph a delta or a junction of rivers?

2. Can you prove that the direction of the arrow is really the direction in which the river flows? On 6005? 6006?

3. Could the islands appearing on these three photographs be presumed to be of alluvial material?

4. Is there any evidence that the shores are of rock or of clay?

5. What do you infer from the distance of the buildings to the water line?

6. On what evidence can you decide that the land extending back some distance from the banks of the river has better drainage than further to the rear?

7. How can you determine which is south shore and which is the north on the air photograph?

8. Can any probability be found on the air photograph to indicate that the high water and the floating ice of the spring flood are more destructive, and the current stronger than at other times of the year?

9. There are light-and dark-toned areas on T 143L-36 and on 6005. Which photograph shows cloud shadows and which shows vegetation tones?

Plate II:

10. Is it possible to determine the direction of the current from what is shown on 6007?

11. What kind of tree is easier to identify on an oblique than on a vertical photograph?

Plate IV:

12. Is there any evidence of sliding on (6031) the bank ?

13. The zone of marsh on 6012 is easily recognizable on the air photograph of Plate I. Can you locate it?

14. Can you determine the direction of the wind from the waves on 6029?

Plate VI:

15. What evidence on 6048 helps to identify Q as quaking asp?

16. How do you know that the trees marked W are white spruce and not quaking asp?

Plate IX:

17. How do you know that the areas marked P are not black rock or black soil?

Plate XIV

18. Does the evenness of the white band on the banks of the river indicate sand or rock?

Plate XVIII

19. What effect would beaver damming have on the surrounding vegetation.

QUESTIONS ON PLATES IN PART I

Plate I

20. Which of the photographs is infra-red?

21. How is the marsh delimited in the top stereo pair?

Plate II

22. How is the direction of the wind indicated by these photographs?

Plate III

23. How are the types of soil and the water table indicated on the photos?

Plate V

24. How could you tell that the channel in the upper stereo pair is not a path trampled by man?

ANSWERS

1. A junction.

2. By the way the tributaries come together.

3. Yes, from the fact they are in the river and from the regularity of their "tear-shape".

4. The smooth shore lines without any abrupt changes of direction, etc.

5. That the spring floods rise high enough to make it necessary to place the buildings at this distance to avoid inundation.

6. The zone nearer the shore from its darker tone is wooded, the light-toned zone still further away is a marsh, i.e. treeless; hence the zone nearer the bank is less water-logged.

7. On the average the south facing shore is much drier, has less vegetative cover and shows considerably more white or very light-toned banks.

8. These summer photographs show evidence of much high water-levels.

9. On the first the differently-toned areas roughly parallel the river banks and the drainage pattern but on 6005 the light and dark areas are independent of the features on the landscape.

10. Yes, the driftwood points down stream.

11. Any kind of a tree.

12. Yes a large erosion scar especially since the trees stop abruptly at the rim of the erosion scar.

13. The light-toned area indicates the marsh.

14. The wind is coming from the left.

15. The practically white bark.

16. By the regular conical shape of the crown outlined against the sky.

17. Under magnification or under stereoscope, the texture shows that it is a forest.

18. Rock. Sand would show a band of varying width.

19. It raises the water level and causes the surrounding vegetation to die from water logging.

20. Top stereo pair.

21. By the boundary of the forest which has coarse texture in contrast to the smooth texture of the marsh.

22. The shortness of the branches on one side of the tree indicates the direction from which the wind came.

23. By the definite zones of vegetation, indicated by its height and texture.

24. Because all the cattails on either side of the channel are erect.

GENERAL INDEX TO TECHNICAL REPORT NO 6

PARTS I, II, III and IV

NOTE: Each item is immediately followed by a Roman I, II, III or IV which indicates in which PART the item occurs. This may be followed by "Pl." which indicates plate or by an Arabic numeral which indicates in which section of the respective PART, the item occurs. A small p indicates page number.